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THE EVOLUTION OF LANDSCAPE IN LOWER NUBIA

BY

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The lower reach of the Nile through Egypt, is regarded by many writers as the result of normal water-erosion [1]. Sandford and Arkell are definitely against the suggestion that the formation of this slot-like valley was in any way connected with rifting. They even refuse Ball's suggestion [2] that the changes in the river course at the Aswan channels were connected with tectonic activities. As for Lower Nubia, the sharply-cut sandstone banks of the Nile, the breaching of the Nile channels through the solid granitic islands of the first cataract and the formation of the two gorges at Silsilah all these facts are attributable only to normal water-erosion. There seems to be no evidence at all to suggest that tectonic activities have caused the formation of the abandoned channels of the Nile at Aswan (the eastern channel is utilised for the railway connection between Aswan and Shellal, and through the western one, runs the road from Aswan to the Dam). The disproof of Dr. Ball's hypothesis of faulting lies in the fact that the two abandoned channels fell into disuse not at the same time but at widely separated times [3].

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(1) Huzayyin, S.A., *The place of Egypt in Prehistory,* Cairo, 1941, pp. 150-153.

(2) See Ball, J., «A description of the first or Aswan cataract of the Nile». *Egypt Survey Dept.,* Cairo 1907.

(3) Sandford, K.S. and Arkell, W.J., *Paleolithic Man and the Nile Valley in Nubia and Upper Egypt,* Chicago, 1933, pp. 57-59.

I. – STRUCTURAL EVOLUTION.

1. The Palaeogene :

Concerning the geological history of lower Nubia, an Archaean [1] or at least Palaeozoic age can be assigned with probability to the main igneous and metamorphic masses. The position of these rocks occurring at the cataract exhibits characters which suggest they are the older parts of such masses. It may be well, having thus obtained a starting point of geological age, to outline as far as possible the geolocical history of the district.

The history opens with the deposition of the igneous [2] rocks which now form the gneisses and schists in the peripheral portion of the district round Aswan. Whether or not these formed the original crust of consolidation of the earth is not certain; but microscopic examination proves an igneous and not a sedimentary origin for them. It is considered that the compression of these rocks as a result of the contraction of the earth's crust, produced the foliated structure which is one of their most marked characteristics. This foliation was apparently followed by intrusions of the fine-grained granite, partly in sheets coursing along the foliated [3] planes and partly in irregular masses. At a later epoch the coarse-grained granite and granodiorites were forced in among these older rocks. From the size of the crystals we infer that this granite probably consolidated at a great depth below the surface and its present-day exposure shows that great denudation has ensued. Continual contraction went on and converted much of the rock of this compound mass into gneiss and still further, altered the surrounding masses, while dykes and irregular masses of coarse pegmatite were intruded

(1) Ball, J., «A description of the first or Aswan cataract of the Nile». *Egypt Survey Dept.*, 1907, pp. 94-95.

(2) Igneous rocks formed in the Archaeozoic and Proterzoic eras occupy one tenth of the present land surface of Egypt.

(3) Which usually strike north-north-west and dip strongly westward, frequently approaching vertical.

into cracks in it. These coarse pegmatite dykes [1] are found only in the older deep-seated igneous and metamorphic rocks. Further compression with the production of faults and fissures followed and felsite and porphyrite dykes were injected into them, while at a still later date more basic dykes and laccolitic masses of basalt and porphyrite were intruded. Signs are not wanting, in the fineness of crystallisation of these rocks (especially at their edges), to show that the felsite and basaltic dykes were intruded at a period when the surrounding masses were cool and relatively unburdened. Long denudation may be inferred between the formation of the earlier pegmatite dykes and the later felsitic and basaltic dykes, the latest of which may have been intruded in the Cretaceous period. In Aswan district, none of the basic intrusions has invaded the Cretaceous strata [2]. The movements which caused all the foliation, fissuring and faulting probably raised the earth's crust into mountain ranges, but in the cataract district, these ancient elevations were planed down by denudation into mere stumps, and the Cretaceous sea or estuary gradually covered them with conglomerates, sandstones and clays [3]. It is most likely that the sea encroached gradually southwards, so that while successively deeper water deposits accumulated to the north, the shallow water conglomerates and grits were deposited in successively lower latitudes. The material of the sandstones may well have been derived from the denudation of mountains to the south, which are composed of similar igneous rocks to those of the cataract region. J.W. Dawson's conclusion « that the Nubian sandstone is the oldest formation on the Nile next to the old crystalline rocks to which it clings all along their margin and from whose waste it is obviously derived» [4]; coincides closely with what had been stated afterwards by

(1) Little, O.H. and Attia, M.A., «The development of Aswan district with notes on the minerals of South-Eastern Egypt». *Survey of Egypt*, Giza (Orman) 1943, pp. 27-28.

(2) Ball, J., *A description of the first or Aswan Cataract of the Nile*, Cairo Govt. Press, 1907, p. 95.

(3) *Ibid.*, p. 95.

(4) Dawson, J.W., «Notes on the Geology of the Nile Valley». *Geol. Magazine*, London, 1884, pp. 391-393.

Drs. Ball and Hume. But Dawson added « that the sandstone may not improbably be a Palaeozoic deposit, the upper part of which has been mixed with the early (lower) Cretaceous beds and the fossils obtained in the formation of sandstone a Palaeozoic rather than a Mesozoic origin (e.g. Dadoxylon specimens of this wood have been obtained at Aswan and Kom Ombo) ... therefore; it would seem that we have in Upper Egypt (and in Sinai) an Upper Palaeozoic sandstone». It is clear here that Dawson's statement about the age of the Nubian sandstone was not in the least supported by a wide geological investigation and the samples of fossils he had taken were not scrutinised microscopically, and reliance on such vague consequences is dubious and invalid. Further investigations about the age of the Nubian sandstone convince us that they are Cretaceous [1].

Subsidence continuing after the deposition of the Nubian sandstone, the Cretaceous and Eocene seas rolled over what is now the cataract area; the thick beds of clays and limestones which they deposited have disappeared in subsequent denudation periods [2]. But at Jebel Garra [3] only 34 kilometres west of the cataract, a thickness of over 300 metres of these marine accumulations conformably overlies the sandstone, and these beds must have extended over where the cataract now is.

About the end of the Eocene period, a great elevation of this part of the earth's crust took place and what had been the sea-bottom became dry land. It was after this elevation that the Nile had its origin, though the river probably did not occupy its present channel until the Pliocene

(1) Dr. Ball found two fossils near the western end of the Aswan dam identified by Blanckenhorn as *Inoceramus cripsi*. Bullen Newton (Newton, R. Bullen : «On some fossils from the Nubia sandstone series of Egypt». *Geol. Mag.*, London, 1909, pp. 352-359 and 388-397) re-examined these specimens and also a collection of fossils from the Nubian sandstone which had been found by Dr. Hume and Messrs. Murray and Crosthwaite, at Jowikol on the east bank of the river Nile, 40 kilometres south of Aswan. Newton was determined that the fossils belonged to a group of forms which are restricted to Upper Cretaceous rocks and mostly to the Campanian.

(2) Ball, J., A description of the first or Aswan cataract of the Nile». Cairo, *Survey Dept.*, 1907, pp. 95-96.

(3) See Ball, J., «Gebel Garra and the oasis of Kurkur, Cairo», *Survey Dept.*, 1902.

period. As already mentioned, there is no need at all to accept Dr. Ball's statement « that the river occupied its present-day channel, when considerable earth-movements took place in north-east Africa». The formation of the Nile's channel in its lower reaches must not be correlated with any rifting or any tectonic activity and many writers emphasised the fact that it is a direct result of normal water-erosion. But we must not reject entirely the theory of faulting and tectonics for there is a number of well-marked dislocations in the desert close to the east of the cataract that have not been surveyed by Dr. Ball. Thus tectonic influence may be significant locally. Nevertheless some information concerning these faults were gathered by Dr. Ball in traversing the desert during a triangulation of Lower Nubia in 1902. Several well-defined faults can be traced within the cataract district.

2. The Neogene :

The recent [1] geological history of this part of the Nile lies in two physiographic cycles. (*a*) In Miocene or late Oligocene, a period of degredation occurred (or more clearly the Pontic Pluvial Period). Consequently the tableland of Eocene deposits was raised to an unknown height with the result that an Oligocene river or presumably the Ur-Nil of Blankenhorn [2] (Das Libische Ur-Nil) carved a long gorge through which the Nile still flows. (*b*) In Pliocene times, the lower reaches of the Nile Valley were pictured by geologists as a narrow gulf of the Mediterranean and the Marine Pliocene of Lower and Middle Egypt was deposited near the mouth of a long narrow fjord-like gulf in direct communication with the flooded river valley of Upper Egypt. The Pliocene deposits on the east bank of the Nile in Lower and Middle Egypt have been described by Blankenhorn who found marine Middle and Upper Pliocene fossils as far as El-Fashn (about 100 miles south of Cairo). Sandford [3] described the unfossiliferous deposits of Upper

(1) Huzayyin, S.A., *The place of Egypt in Prehistory,* Cairo, 1941, pp. 150-153.

(2) Blankenhorn, Max, *Geologie Agyptens,* Berlin, 1919.

(3) Sandford, K.S., «The Pliocene and Pleistocene deposits of Wadi Qena and of the Nile Valley between Luxor and Asiut». *Q.J.G.S.*, LXXXV (1929, pp. 493-548).

Egypt from Asiut to Luxor and stated that they may be connected with the deposits of Blankenhorn but differ in being laid down in fresh waters. During 1928 the Survey of Egypt published a layered map of the Theban Necropolis and its environs on the scale of 1 : 10,000 with contours at vertical intervals of 10 metres. By sketching upon this map the boundaries of [1] the Pliocene deposits, it is easy to obtain a tolerably accurate idea of the level of the water in which they were laid down. We assume now that the flat-topped or the gently sloping plarform of the Pliocene conglomerates rises everywhere just above the 1·80 metres contour. This we have little doubt represents the water level at the end and probably during a large part of later Pliocene times. It is essential to know as well, how far this Pliocene immersion extended towards the south. Did it flood the great depressions of the western desert ? How far up the Nile Valley did the gulf continue ?

The 200 metres contour follows the foot of the Eocene cliffs west of the Nile Valley as far as Gebel Garra on the latitude of Aswan (24° 5'). A few miles further south, the Eocene escarpment turns away westward ; but the 200 metres instead of turning with it, continues due south until it reaches the Nile Valley opposite the mouth of Wadi el-Alaqui. Therefore, a ridge of Nubian Sandstone rising above the 200 metres contour separates the Nile Valley from the low ground draining into the depressions of the western desert. Such a ridge of 40 kilometres wide at its narrowest point, would have constituted an effective barrier against any westerly extension of a sheet of water having an altitude of 180 metres [2]. Going upstream from the first cataract the river runs through a narrow threadlike valley hemmed in by high ground and it is most improbable that any continuous sheet of water ever extended up this reach in Pliocene time. Sandford and Arkell [3] after scrutinising

(1) H.J.L. Beadnell delineated the boundaries of the Pliocene deposits in 1897, but no topographical map existed then as a basis.

(2) Despite this the possibility of connection between the depression of Kurkur and Khargah oasis to the west of Aswan on one hand and the Nile Valley on the other cannot be ignored.

(3) Sandford, K.S. and Arkell, W.J., *Palaeolithic Man and the Nile Valley in Nubia and Upper Egypt,* Chicago, 1933, p. 12.

the Pliocene deposits along the Nile declared that any conception of a Pliocene gulf extending far south of the first cataract is untenable, and that the erosion (degredation) of the Pontic Pluvial Period (that co-ordinates with the Miocene or Late Oligocene) and caused the excavation of the Nile Valley of Egypt) resulted in Nubia in a general lowering of the country and the removal of the Eocene and Cretaceous strata.

In Upper Pliocene, the sea retreated again and the present drainage pattern was established gradually.

3. In the Pleistocene :

In Plio-Pleistocene and Pleistocene times there is every evidence that the river's valley was cut. A strong indication of such a recent origin of the existing valley is the fact that it is almost everywhere bordered on both sides by rock terraces [1]. A series of these terraces have been cut into the Pliocene marine sediments at the approximate heights of 110-100, 65-60, 50-45, 30, 17-15, 10-8 and 3 metres above the present valley level. It seems inconceivable that the cutting down of the river in Pleistocene times could have followed so exactly the meanders of the earlier period of degradation that took place in Miocene or presumably the Pontic Pluvial times and yet the meanders left no trace of the deposits that filled them. More probable would seem the suggestion that during and before the Pontic Pluvial Period when the ancestral Nile (the Ur-Nil of Blankenhorn) was cutting its deep gorge through the Cretaceous and Eocene formations, it derived a large portion of its water from rainfall over the Red Sea mountains. This caused a general lowering or, in other words, an entire degradation of the country over which the Nile south of Esna [2] now flows. This general lowering of the country could not have been accomplished by a single river system but only by innumerable streams collecting a heavy rainfall. Such tributary system is represented in the Wadis, Shoki and Abbad (which debouch near Edfu) Kharit and Shait (both debouch to the east of Kom Ombo town).

(1) Huzayyin, S.A., *The place of Egypt in Prehistory,* Cairo, 1941, pp. 152-153.

(2) Esna lies 150 Kilometres to the north of Aswan.

After the formation of the above mentioned terraces, the Nile appears to have deepened its lowermost course to an unknown depth. In middle Egypt, it cut a deep channel which later on (in Sabilian or middle and upper Palaeolithic times) was filled with more recent and entirely different mud, in constitution from the coarser pebbles and debris which came from the Red Sea mountains and which was responsible for the building of the terraces proper.

Dr. Ball's hypothesis of Lake Sudd (which extended from the Sudd region northwards to beyond Khartoum, a distance of 1050 kilometres) provides an explanation of this phase of silt deposition as well as the silting of the abandoned valleys to the east of Aswan and the arrival for the first time of Abyssinian mud. As he remarks [1], « During the period immediately following the tapping of the lake, there would be not only a considerable increase in the volume of water passing down through the cataract region into Egypt, but also a very considerable increase in the relative silt-content of the waters».

Both the origin of the early Sabilian silts and their rapid deposition in Upper Egypt are thus readily explained. The silts represent sediments which for a long time previously had been gradually accumulating in the northern part of Lake Sudd and their transport to, and deposition in, the Egyptian portion of the Nile Valley was due to the tapping of Lake Sudd which brought its waters and those of the White and Blue Niles into the Nile system.

It is worth mentioning here that the coarser igneous materials which built the terraces proper, were carried down to the Nile Valley by the tributary systems of the Wadis of the eastern desert *before the onset of desert condition* in Upper Palaeolithic times. Meanwhile the fine Sabilian silts of the Upper Palaeolithic were deposited after the expiration of the Pluvial age and absolute domination of desert conditions. Otherwise these fine silts would have been easily washed down to the sea by the torrential and turbulent Wadis of the eastern desert.

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[1] BALL, J., *Contribution to the geography of Egypt,* Govt. Press, Cairo, 1939, pp. 74-83.

The story in uppermost Egypt [1] and Nubia is somewhat different from that further north. The above mentioned phase of degradation in the north was counteracted by a phase of aggradation in the south. This aggradation was marked by increased deposition of Abyssinian mud in this region. The mud has largely marked the lower terraces and at Wadi Halfa, it reached as high as 30 metres above the present level of the river, losing height relatively northwards until it entirely disappears under the present-day floodplain near Naga Hammadi.

In middle Sabilian (Egyptian late Upper Palaeolithic stage), aggradation in Nubia and Uppermost Egypt gave way to degradation with the result that the river fell again and cut its way down through the silts piled up in the preceding phase of aggradation. But in Middle and Lower Egypt, aggradation continued afterwards in Upper Sabilian times and is still continuing throughout Egypt at least as far as the first cataract. This aggradation is proved by the fact that the temples built on the alluvial flood plain by Dynastic Egyptians are already partly buried. Each year, the summer inundation adds its quota to the pile of sediments already accumulated.

Attempts have been made by archaeologists to estimate the rate of accumulation of the silt (present alluvium) in historic times by measuring the extent to which monuments of known date have been buried. By this means, Sir Flinders Petrie has arrived at an average figure of 4 ½ inches per century, noticing that local conditions cause great variability.

The process of aggradation and degradation in a river system is attributable to the change in the supply of water and material (which if increased would bring inundations and a rise in the bed of the river and vice versa) together with the oscillations in base or sea-level (which if lowered would increase the degrading power of the river and if raised, would help first the formation of marshes and then their silting up by aggradation) [2].

Prior to the construction of the Aswan Dam, the Nile was degrading its course in Nubia, while it was aggrading it in Egypt proper. The

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[1] SANDFORD, K.S. and ARKELL, W.J., *op. cit.,* p. 153.
[2] HUZAYYIN, S.A., *The place of Egypt in Prehistory,* Cairo, 1941, p. 321.

area of this research is now entirely under the influence of aggradation, although aggradation is more clearly marked if we go further down-stream.

II. — LANDSCAPE EVOLUTION.

In the previous section, an attempt has been made to outline the structural evolution of the northern portion of Aswan Province in relation to the different geological periods and physiographical cycles that occurred throughout Egypt. In the following paragraphs, a similar attempt will be achieved to define the landscape evolution of that part of Egypt, despite the fact that any research in that branch of geography is usually obscure and ambiguous, owing to the inadequacy of the available geological and physiographical data relevant to the area under review.

1. Climate :

It is essential to begin the study of this chapter by making a summary of the climate during the remarkable phases of the history of the Nile with their accompanying formation of terraces and the abandonment of the eastern river channels.

There is every reason to support the view that the part of the Nile draining into the area of this research, received a considerable rainfall during the Pontic Pluvial Period of the Miocene and the Pluvial Period of Upper Pliocene times, and judging by the Pliocene deposits, it was abnormally heavy. Edward Hull's [1] views were that climatic conditions were similar to those of Europe at the present day, both as regards temperature and rainfall; and of course if we take this into consideration, it is easy to account for the vastly greater volume of the Nile waters in those days. But establishing a similarity between the climate of Europe and that of Egypt during the Pluvial Period, is really very vague. Europe is a continent with different climatic regions, and naturally precipitation

[1] Hull, E., «Observations on the geology of the Nile Valley and on the evidence of the greater volume of the river at a former period». *Q.J.G.S.*, vol. 52, 1896, p. 319.

is not the same in all its differing parts. C.P. Brooks [1] stated that the climatic regions of Europe as we know them now, were during the Glacial Period corresponding with the Pluvial Period in N. Africa, extending far south. In other words the northern latitudes were pressed towards the equator. Accordingly the arctic climate extended to Northern Europe, that of Northern Europe to Southern Europe, and the Mediterranean climate dominated over the northern part of Africa. Consequently, the climate of Egypt during the Pluvial Period was probably similar to that of Southern France or Italy at the present time, with abundant rainfall during the winter and very scarce rains or even absolute aridity in summer. However, we must not go further than this, as long as there are no real evidences to support even the above view.

There is no sign at all of any desert period before Pleistocene times. The eastern hills were the main source of surface water and the dry wadis at present were strong and turbulent torrents.

At [2] the close of Lower Palaeolithic times a change is noticeable in the tributary streams of Nubia (to the south of the first cataract). There seems to have been a marked reduction of run-off even on the east bank of the Nile. There is no substantial evidence for such a failing water supply in Upper Egypt even in early Mousterian times (middle Palaeolithic). The deposits of the Mousterian Period in the area to the north of the first cataract suggest, however, sporadic torrents rather than evenly distributed rainfall, with no sign at all of wind erosion or desert climate.

In the Sabilian silt phase, the local rainfall survived [3] in some small measure. In view of the large areas of silt surviving in exposed places in the area (e.g. in Kom Ombo basin) it must be assumed that the rainfall had virtually ceased in Upper Egypt by Upper Sabilian times. The sand that accompanied the silt phase, accumulated locally near the river in small dunes. It was derived, however, from the western desert,

[1] Brooks, C.P., *Climate throughout the ages,* London, 1932, pp. 314-317.
[2] Sandford, K.S. and Arkell, W.J., *Palaeolithic Man and the Nile in Nubia and Upper Egypt,* Chicago, 1933, pp. 85-86.
[3] *Ibid.,* p. 86.

where climatic conditions differed from those of the Nile valley proper during an earlier period.

2. Physiographic history of the Nile :

Returning again to the study of landscape evolution, there is no doubt that the Nile comprises the main feature of geography in Egypt and that it was subject to many changes in the course of its geological history. The evidences of such changes are insufficient to contribute to a comprehensive study of the history of the Nile and its evolution. Edward Hull [1] was one of the first geologists who treated this subject and confined his research to the problem of the decrease in the volume of water carried by the Nile at the present day. The evidence that the Nile was once a river of vastly greater volume than at the present day is so remarkable that it attracted the attention of many writers amongst whom may be especially mentioned Professor Leith Adams [2], Professor Zittel and Captain Lyons.

The evidence [3] upon which the former greater volume of the Nile waters is inferred lies in two consideration : (i) the river terraces now beyond the reach of the highest floods, (ii) the old river-channels through which the waters cannot now pass owing to their higher altitude.

(*a*) The river-terraces :

Mention has been made of the series of terraces cut into the Pliocene marine sediments at the approximate height of 110-100, 65-60, 50-45, 30, 17-15, 10-8 and 3 metres. Naturally all these terraces can hardly be found in complete succession one upon the other in the northern

[1] Hull, E., «Observations on the geology of the Nile Valley and on the evidence on the greater volume of the river at a former period». *Q.J.G.S.*, vol. 52, 1896, pp. 308-319.

[2] Adams, Leith, «On the geology of a Portion of the Nile Valley...etc.», *Q.J.G.S.*, vol. 20, 1864, p. 6.

[3] Hull, E., «Observations on the geology of the Nile Valley and on the evidence of the greater volume of the river at a former period». *Q.J.G.S.*, vol. 52, 1896, p. 312.

part of Aswan Province, for the erosive effect of the river must be taken into consideration. For this reason the high group of terraces is not recognisable in the area because the towering heights of the Cretaceous and Eocene hills were protected from the river by the Pliocene lining of the valley, this in turn being soft, has suffered severely from Pleistocene and recent erosion and the high terraces have therefore crumbled down.

Sandford and Arkell [1] mapped and measured a series of terraces which they divided as follows :

(i) *The Plio-Pleistocene Terraces :*

These may be divided into the high group and the 150 group, the high group has been entirely destroyed in the northern portion of Aswan and in Upper Egypt as a whole. As for the 150 foot terrace, it appears on the surface of the Nubian sandstone between the Nile and Gebel el Borg about 10 miles north of the first cataract. It also becomes the dominant feature on the west bank of the Nile opposite Daraw, as an unbroken gravel-strewn plateau and continues its northerly course on the west side of Gebel Silsilah to Edfu. This plateau was supplied by vast quantities of gravel by Wadi Shait and Wadi Karit across the site of the present Kom Ombo plain. The gravel is about 25 feet in thickness and forms an undulating plain which is five miles wide opposite Edfu and local quartz and gravels from the Lybian desert reinforce its western side. Along the eastern bank of the Nile the 150 foot platform may be seen at intervals only to the north of Gebel Silsilah for it has suffered severely from subsequent denudations (during the second period of fluvial denudation which may be designated the pluvial period).

(ii) *The lower Palaeolithic stage of the Pleistocene (The 100 foot terrace) :*

The gravels of the 100 foot terrace appear and play an important part in damming that branch of the cataract now utilised by the railway from Aswan to Shellal to the east of Aswan. The gravels of this terrace are conspicuous for the considerable size of their pebbles, most of them

[1] Sandford and Arkell, *op. cit.*, pp. 18-24.

being well rolled and polished. The height of this gravelly valley is 96 feet above flood plain at Shellal to the south of Aswan. In the eastern border of the plain of Kom Ombo [1], there are few hills scattered with coarse pebble beds at about 100 feet above the Nile flood plain. Similar gravels occur on the hills near the Nile north of Aklit and rise to 100 feet. Others project through the silt of the Kom Ombo plain itself.

West of the Nile, the gravels of the 150 foot terrace form the sky line, with traces of a 100 foot terrace across the Nileward spur. On the eastern side of the Nile, to the north of Kom Ombo, the 100 foot platform narrows to the Silsilah gorge, where a deeply incised 100 foot, gravelly valley flanks the present rocky channel of the Nile. The 150 foot terrace continues also unbroken on a northerly course west of the Silsilah barrier. This 150 foot terrace marks the passage of one arm of the river over the hills themselves. This branch persisted in later times through the 100 foot stage and all later stages until the modern ravine was cut through the barrier. In the Lower Palaeolithic stage (the 100 foot terrace times) another eastern branch of the Nile augmented by the eastern Wadis Kharit and Shait passed east of Gebel Silsilah itself and started eroding the valley now choked with late Palaeolithic silts through which the railway makes its way.

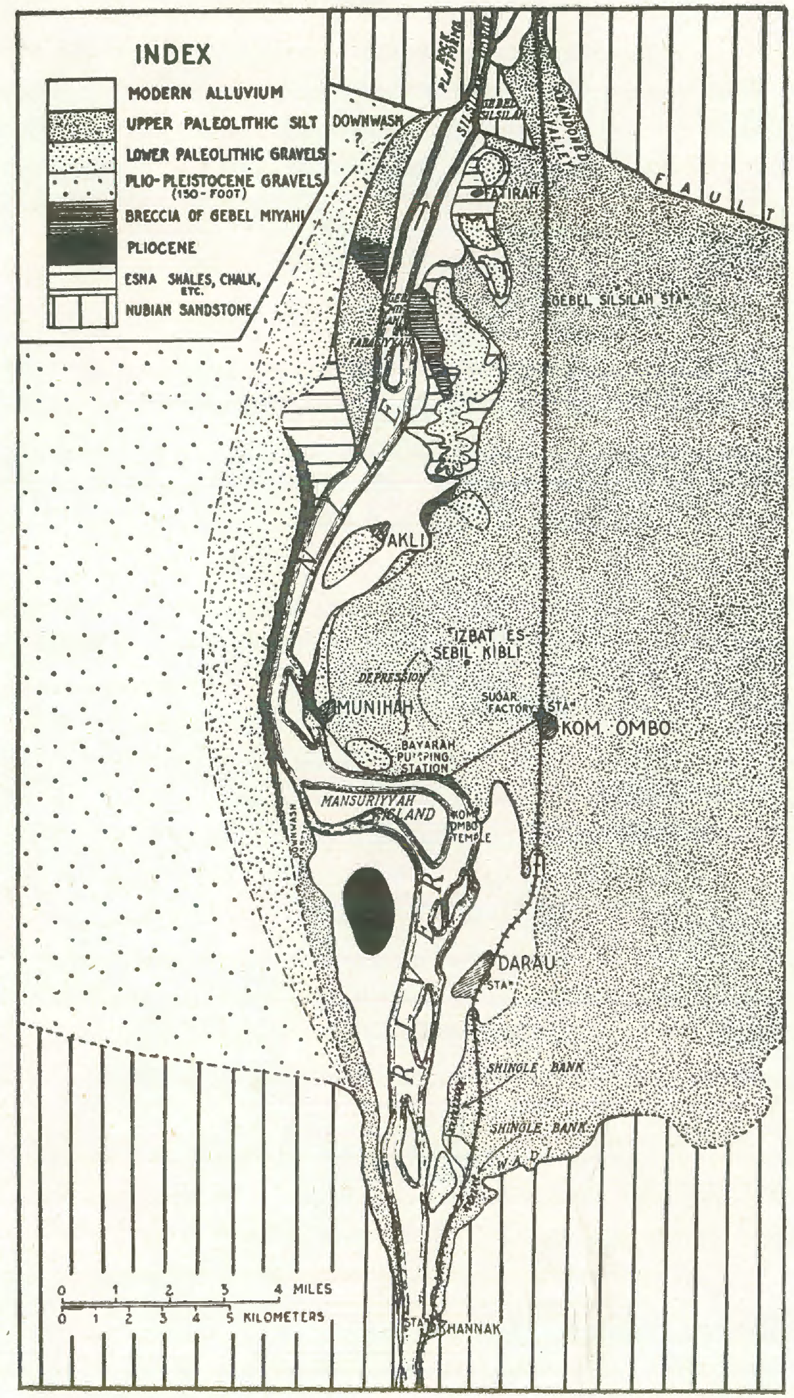
(iii) *The 50 foot terrace* [2] :

The Platform of this terrace is not well marked between Aswan and Kom Ombo plain. North of the plain, it is very clearly marked as far as Isnà. To the east of the present course of the Nile, there is evidence of a once existing river channel, which recently lies beneath the silts of the Kom Ombo plain. The channel probably branches somewhere south of Gebel Silsilah [3]. The 50 foot platform can also be traced on

[1] The Kom Ombo plain itself is about 60 feet above the river level.

[2] Sandford, K.S. and Arkell, W.J., *Palaeolithic Man and the Nile Valley in Nubia and Upper Egypt,* Chicago, 1933, pp. 31-35.

[3] These two branches of that old channel flowed over the Gebel Silsilah barrier, cutting deep trenches. Of these, one is now the only passage by which the Nile negotiates the rocky ridge; the other became choked with silt late in Palaeolithic times and is now utilised for the railway.



the east side of the Nile from the Bayyarah pumping station to the mouth of the Silsilah gorge, where low gravel hills border the flood plain attaining a height of 50 feet and sloping steeply towards the east and dipping beneath the Kom Ombo silts. Immediately south of Fatirah village about 4 miles south of G. Silsilah, flat-topped hills run parallel to the Nile and stretch about a mile east of it for two or three miles.

(iv) *The Middle Palaeolithic* [1] *stage (Mousterian) :*

In Mousterian times, the Nile changed from a great river capable of excavating a deep valley and of hurrying along a vast load of pebbles, and descended to its present form. The descent is marked by the two low terraces of Upper Egypt (30 and 15 feet). This is the phase of aggradation marked by an increase in the deposition of Abyssinian mud in this region. The mud has largely marked these two lower terraces, reaching 30 metres above the present level of the river at Wadi Halfa and falling down as we go northwards until it disappears near Naga Hammadi. This means that the Middle Palaeolithic mud is found nearly everywhere in lower Nubia with decreasing height as we go northwards. This phase of aggradation is responsible for filling the Kom Ombo basin with silt until it attained its maximum level. The silt in the basin occupies an area of considerably more than 50 square miles mounting with variable thickness to some 60 feet above the present flood plain. All the mouths of the former watercourses descending from the two bold escarpments bounding the Nile valley and reaching the main drainage channel of the country now occupied by the Nile, are now choked for many kilometres by an immense deposit of silt thirty metres deep [2]. The pre-historians have named these silts « Sabilian» after finding artifacts in them at Sabil near Kom Ombo. The Sabilian silts are also well developed on the western bank from the northern end of the Silsilah gorge downstream to Edfu.

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[1] *Ibid.,* pp. 35-47.

[2] Murray, G.W., «Desiccation in Egypt». *Bulletin de la Société Royale de Géographie d'Egypte,* Novembre, 1949, p. 19-34.

(v) *The late Palaeolithic stage :*

At the southern end of the Kom Ombo plain close to Daraw, a prominent ridge between the railroad and the Nile draws attention. Here a great shingle bar curves away from the cliffs on the eastern bank near El-Gaafrah and marks the westward curve by which the Nile skirts the Kom Ombo plain. The shingle bar reaches a maximumheight of 40 feet south of Daraw. It may be interpreted as a beach piled up at the southern end of the Kom Ombo lake (special reference will be given to it later) by the prevailing northerly winds.

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This is a summary of the series of terraces traced in lower Nubia as mapped and measured by Sandford and Arkell in their archaeological survey of Upper Egypt and Nubia. Edward Hull in his previously referred article in the Q.J.G.S. stated, « that the evidence derived from the terraces is cumulative, and tends to prove that the original surface of the Nile waters stood at a level varying from 50 to 100 feet or more above that of the present day».

It is most difficult to accept Hull's statement for several reasons. Firstly, at the time he wrote his article (1896), the terraces were not accurately measured and were not even mapped. Secondly, by saying that « the Nile waters stood at a level varying from 50 to 100 feet or more ...», this is sufficient to show that the 150 foot, the 100 foot and the 50 foot terraces were absolutely unknown. It means as well that the greater volume of the Nile was restricted to cover the 30 foot terrace, whilst the higher terraces remained free from water.

Edward Hull attributed the formation of the terraces exclusively to the Pluvial phase that took place during Upper Pliocene and Pleistocene times [1]. There is no doubt that the «Pluvial» and «Interpluvial» Periods

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[1] The Pluvial period is a term first suggested by Mr. Jameson and it is a term indicative of meteorological conditions, and is not restricted to the period represented by the Glacial period of Europe. See Craig, J.I. and Hume, W.F., «The glacial period ... etc. in North and East Africa», *British Association for the Advancement of Science* 1911.

caused respectively an increase and decrease in the volume of water carried by the Nile. In other words, the processes of aggradation and degradation are a direct consequence of any change in the volume of water and material carried by the Nile. But this alone will not give a satisfactory explanation of the formation of terraces. The oscillations in « base» or sea-level are of great importance, and must be taken into consideration when discussing the formation of terraces. If the base is lowered it would cause an increase in the degrading power of the river and if raised, it would help silting up by aggradation.

(*b*) The abandoned river channels :

Aswan is built on the cultivated flood plain downstream of the first cataract and is connected with Shellal upstream of Aswan Dam, not only by the river, but also by two dry valleys lying parallel to each other and to the Nile itself on its eastern side. Along the more easterly of the two valleys the railway connecting Aswan and Shellal is carried for a distance of 7 miles. It is about half a mile wide, running between rugged slopes of granite capped by coarse horizontal Nubian sandstone. The other valley is occupied by the road from Aswan to the Dam. Dr. Ball [1] pointed out that these valleys are now choked with Nile silt and gravel to a height of 29 metres (96 feet) above the level of the present day inundations. In speculating as to the cause which led to the Nile's abandoning these channels and deepening its present course through the cataract region, he was driven to the conclusion that earth movements alone appear to be capable of explaining the westward migration of the river not only as Aswan but at Silsilah [2] as well where the same phenomenon is perceptible. This belief seemed to be confirmed by his discovering a fault across the mouths of the abandoned valleys at Aswan. Meanwhile he ascribed the actual lowering of the present channel almost entirely to erosion with emphasising the effect of pot-holing [3]. The

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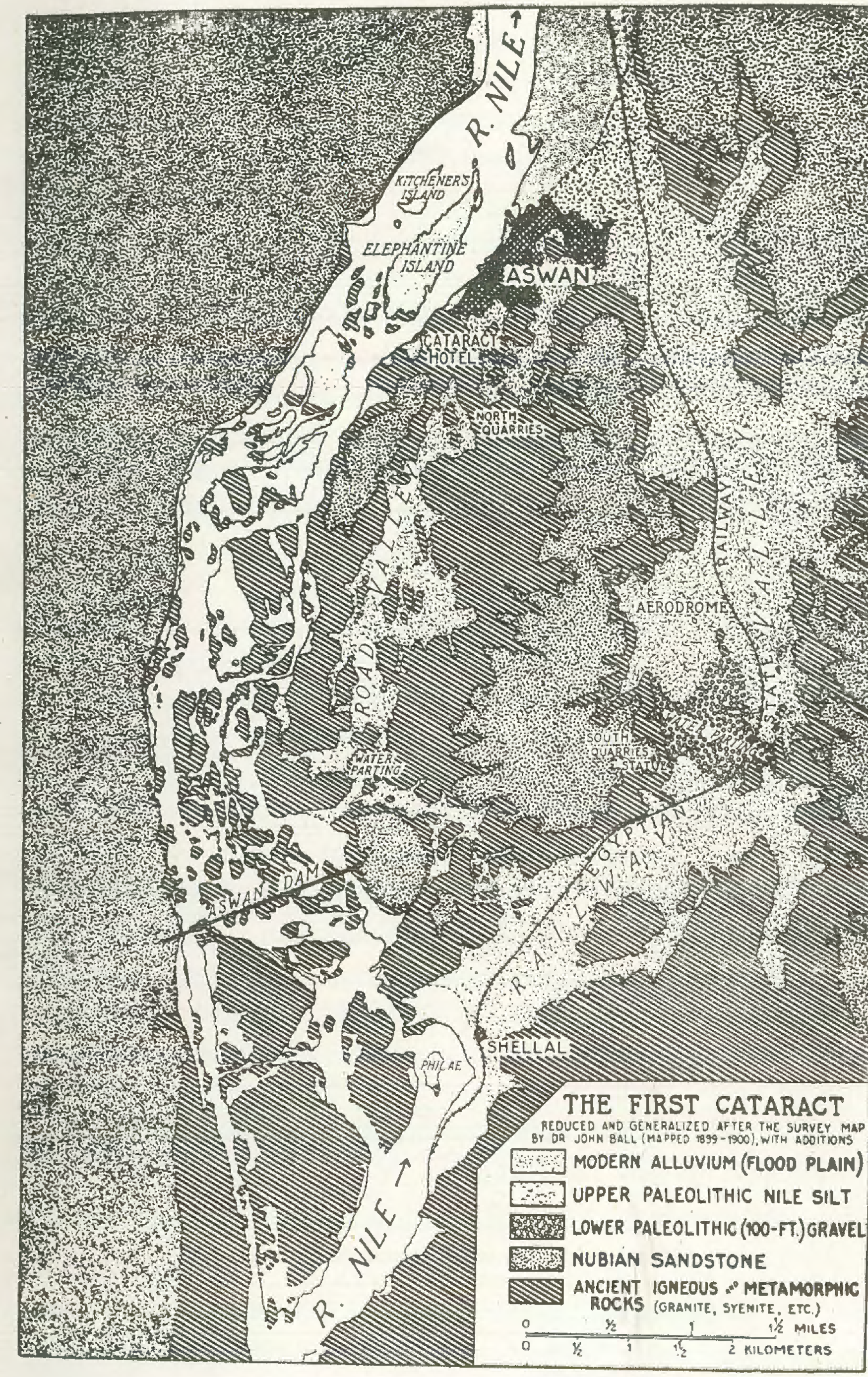
[1] Ball, J., *A description of the first or Aswan cataract of the Nile,* Cairo, Govt. Press, 1907, pp. 100-113.

[2] Silsilah gorge is at a point 60 Kilometres downstream of the first cataract.

[3] Pot-holes are eroded in the hardest rocks by eddying currents acting on sand and stones lodged in the hollows of the surface.



effect of pot-holing in erosion was very much exaggerated by J. Brunhes (in 1902). M.R. Fourtou [1] ascribed also the origin of the Aswan cataract to complex faulting and asserted that Brunhes' statement that pot-holing was the most important factor in the erosion of the present course of the Nile was a great exaggeration and added that the actual constitution of the Nile bed between El Shellal and Aswan is due to a system of rock-fractures still clear and easily verified. He seems in turn to have exaggerated the faulting in the cataract region (though dislocations in the Pre-Cambrian rocks are numerous).

The last date (Quaternary) of the faults postulated by Dr. Ball is a serious obstacle to accepting the faulting hypothesis, for true faults of such recent date are very rare indeed in Egypt [2]. In examining closely the Pleistocene deposits which block the two abandoned valleys, it seems that no such hypothesis is necessary. The deposits consist of two separate elements of very different ages.

The highest Pleistocene material rising to 96 feet above cultivation in the easternmost of the two channels at Aswan may be referred without hesitation to the 100 foot stage or presumably the lower Palaeolithic stage of the Nile because the pebbles are large and well rounded and consist entirely of quartz, quartzite and ironstone derived from the Nubian sandstone.

The second abandoned channel (the central one) through which runs the road from Aswan to the Dam is more a dry cataract channel studded with islands and projecting spurs of granite, than an abandoned river valley. It contains no deposit of coarse gravels corresponding with that in the railway channel. There are some indications that at the 60 foot maximum of aggradation, a minor branch of the Nile passed through it. In a pit on the southern side close to the houses below the Dam, the face of the silt has been worked for Sebakh (manuring) and the ancient granite floor has been laid bare.

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[1] Fourtau, M.R., «La cataracte d'Assouan : Etude de geographie physique», *Bull. Soc. Khedev. de Géogr.*, Le Caire, 1905, pp. 325-364.

[2] Sandford, K.S. and Arkell, W.J., *Palaeolithic Man and the Nile Valley in Nubia and Upper Egypt*, Chicago, 1933, pp. 57-59.

After the abandoning of the eastern valley, the central valley alone would have been inadequate to conduct the whole volume of the Nile. For this reason Sandford and Arkell inferred that the Nile was divided between the central valley and the western one which it now occupies. It is probable, however, in view of the relatively great width of the western channel, that ever since the west-ward retreat from the eastern valley at the end of the 100 foot times, the present day channel together with the central channel have carried the main stream of the Nile. If this is true, the current was probably too strong for the deposition of large quantities of silt and more silt would have tended to accumulate in the narrower central channel. Sandford and Arkell concluded that their observations did not lead them to suggest that any great abnormality had characterised the history of the Nile in the region of the first cataract.

As for the abandoned channel to the east of the Silsilah gorge, (about forty miles below Aswan), Schweinfurth considered that there was certainly a cataract in the Silsilah area at the time of the Kom Ombo lake. The hard sandstone block intervening between the two channels (the abandoned eastern one and the western channel which represents the present course of the Nile) was probably an island in the midst of a long continuous lake. The absence of conspicuous quantities of silt in the gorge had led to the conclusion that Gebel Silsilah was the northern bounding wall of a great lake which occupied the Kom Ombo plain. The lake once flowed out over a barrier or barriers now swept away. Schweinfurth's suggestion of a cataract and M. Vignard's [1] picture of the « bursting through of the barrier» which led to the draining of the lake, both followed as natural consequences.

It is noticeable now, that high silts such as those choking the Kom Ombo basin, also fill the abandoned channel by which the railway passes through Gebel Silsilah. Therefore, the formation of the channel must have taken place before the period of high water in the Kom Ombo plain. Consequently Gebel Silsilah cannot have acted as a cataract or barrier at that period. The most reasonable supposition seems to be that the

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[1] Vignard, M., «L'histoire du Bassin de Kom Ombou». *Bull. Instit. Français d'Archeologie,* vol. XXII.

two gorges were cut at the same time namely, during the first or lower Palaeolithic-Mousterian period of degradation [1].

The ultimate abandoning of the eastern channel during the Sabilian period of degradation was undoubtedly due to the selection by the river of the channel which had become the least blocked with silt during the period of high water (in Middle Palaeolithic times). This in turn would have been determined by the general westerly tendency of the river, as demonstrated by its undercutting the western bank across the Kom Ombo plain. The concentration of the current on the west side which resulted in the cutting of the west channel at the extreme western margin of silt between Meneiha and Silsilah, would have tended to keep the west gorge clear of silt while the east gorge became choked.

Thus, there is also no need here to invoke abnormal agencies such as « bursting of barriers» to ascribe to them the formation of the Silsilah gorges and the abandonment of the eastern channel.

Another abandoned channel of very minor dimensions exists near Mahamid at El-Kab. Here again the dry valley is on the east side of the Nile and has been utilised by the railway to negotiate one of the few points where the rocks fall in cliffs abruptly to the river. It was formed in precisely the same way as the gorges at Silsilah.

As for the cause of the formation of these abandoned channels to the east of the Nile and its tendency to migrate westward, Sandford and Arkell completely disproved Dr. Ball's hypothesis of « earth movements» as the only possible cause for this marked phenomenon in the course of the Nile. They remarked... « It is noticeable that wherever the Nile bed consists of rocks of unusual hardness, nemaely in the cataracts, the existing stream is split into a number of minor channels separated by rocky islands of all sizes, from mere boulders to considerable masses such as those of Philae and Elephantine [2]. It is at these very places that abandoned channels choked with silt are found. The channels of Aswan coincide with the outcrop of the hard rocks forming the first

[1] SANDFORD, K.S. and ARKELL, W.J., *Palaeolithic Man and the Nile in Nubia and Upper Egypt,* Chicago, 1933, pp. 60-61.

[2] The recent name for Elephantine is Gaziret Aswan.

cataract. It is significant that the outcrop of hard rock (the Sandstone Block) at Gebel Silsilah, coincides with the only remaining abandoned channel to the east of the Nile. Thus, to connect the abandoned channels with the outcropping of the hard rocks that give rise to the cataracts and gorges is unavoidable.

An observer standing on the summit of the high hill behind the cataract hotel notices that the whole Nile Valley shrinks to a mere thread and these channels at Aswan become insignificant loops interrupting but for a moment the continuity of the whole [1]. The ridges separating the three valleys shrink to mere islands in a vastly greater cataract. The lateral spread of the river into several forks resulted directly from its inability to deepen a single channel sufficiently to take the whole stream.

Sandford and Arkell's explanation as to the cause of this general tendency on the part of the river to migrate westward, seems quite satisfactory and reasonable, especially if we take into consideration the more recent date of their survey of Nubia and Upper Egypt (1932-1933). Meanwhile, we must not dismiss the question of change (laterial movement of the river) with the easy explanation that in the cataract region of Aswan the volume of water of the river passing through it is divided into several arms and channels hemmed in amongst the islands and rugged ridges of igneous rocks. The river has in the course of its long history, simply eroded the softest of these channels more deeply than the rest and then ultimately occupied this deeper channel only. Nevertheless, soundings have not been made in the three channels to determine which of them was composed of softer material.

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A quick review must be made here on the history of the Kom Ombo basin. M. Vignard [2] has summarised its periods as follows :

(i) An ancient period of filling up the basin with gravels during the first period of high water level which occurred during the

[1] The model geological map of the first cataract in the Royal Geog. Soc. of Egypt, prepared by Ubinosi and G. Busuttil at a vertical scale of 1 : 500 and a horizontal one of 1 : 5,000, clearly portrays such a view.

[2] VIGNARD, M., *op. cit.*

150 foot and 100 foot stages or in other words during the Plio-Pleistocene and the Lower Palaeolithic stage of the Pleistocene. These gravels have suffered severely from the subsequent period of denudation. As a result they may be seen only at intervals to the south of Gebel Silsilah.

(ii) A Mousterian period of vertical erosion.

(iii) A post-Mousterian and Lower Sabilian period of high water during the Pluvial period when the basin was filled with silt and the maximum level attained. It is obvious that Gebel Silsilah constituted the northern bounding wall, which at one time held back the Nile's waters in the form [1] of a great lake of which the Kom Ombo plain is a conspicuous relic. In Kom Ombo district, the silt occupies an area of more than 50 square miles, with an average of variable thickness of 60 feet above the present flood plain.

(iv) A middle and upper Sabilian period of vertical erosion with increasing desiccation.

It is noteworthy here that the shingle bar previously mentioned as a relic to the late Palaeolithic stage may be described as a beach accumulated at the southern end of the Kom Ombo lake by the northerly winds. But because the bar's level — if it represents a beach — is 20 feet below the highest level attained by the lake, it can only be a beach formed during a pause in the contraction of the lake in the phase of degradation. The absence of a shingle bar at the period of highest water levels, shows the likelihood that the Kom Ombo basin was not a lake similar to that of Fayyum [2], but a marsh or a network of pools and mud flats comparable perhaps with parts of the Sudd region in Upper Sudan.

It must be noted here, that habitation in the plain was impossible until the mud flats were abandoned by the Nile and became swamps.

[1] Hume, W.F., *Geology of Egypt,* vol. I, The surface features of Egypt, their determining causes and relation to geological structure. Govt. Press, Cairo, 1925.

[2] The lake in the Fayyum depression is called Lake Qarun and is 45 metres below sea level.

Along the draining channels and round the swampy lakes and ponds, man and riverside mammals established themselves. Remains of these mammals [1] which have been found in association with Upper Palaeolithic (Sabilian) formations, include the hippopotamus, the lion, the great buffalo, small equid, small rodents, fishes ... etc.

Thus an attempt has been made to outline the landscape evolution in Lower Nubia. It is very difficult to outline the intricate features that characterise the Nile's course in this area. However, a picture has been drawn with a great deal of accuracy, though it is unfair to devote so few pages to this important evolutionary side of the geography of the Nile.

[1] Huzayyin, S.A., *The place of Egypt in Prehistory,* Cairo, 1941, p. 81.

SOME GEOGRAPHICAL ASPECTS OF AL RIYADH

(SAUDI ARABIA)

BY

M. T. ABUL-ELA

PHYSICAL ENVIRONMENT

1. Location.

Al Riyadh stands on the eastern bank of Wadi Hanifah, just south of the junction of Wadi Al Aysan and Wadi Hanifah. Moreover, Wadi Al Bat'ha runs on the east side of the town. Thus, it is situated at the confluence of three major arterial Wadis (Fig. 1).

The advantageous site of Al Riyadh on the east bank of Wadi Hanifah is greatly enhanced, as it stands on a point where the wadi has been enriched by water from its rich tributaries : Wadi Wubair and Wadi Qaddiyah north of Al Riyadh. In the mean time wadi Numar — one of the feeders of wadi Hanifah — runs direct south of al Riyadh.

Such a site helps the town to make use of the waters of wadi Hanifah as well as its other five tributaries. This wellendowed situation has given Al Riyadh its name which literally means a cluster of gardens, palm trees and other vegetation. Also this name is very significant when compared with the desert landscape all around.

The town lies on an eroded depression in the jurassic plateau, 1950 feet (594 meters) above sea-level, at the intersection of the north latitude 24° 42′ and the east longitude 46° 44′.

Riyadh Basin Complex :

Al Riyadh and the near villages, *i.e.* Manfuhah, Al- Dir'iyah and Al Ammariyah, form a basin which represents the oikoumene part of north eastern Najd. This basin was formerly called Al Arid. Al Kharj and the other villages of Al Yammamah, Al Sulaymaniyah, Al Salamiyah, Al

Ghanamiyah, Al Thulaymah, Al Hayatim, Al Mohamadi, Ad Dilam, and Na'jan, form another basin 80 kms to the south east of the former basin. In this basin many Wadis conflow; from the north and north-west, wadi As Sulayy, Wadi Al Haniyah and Wadi Hanifah flow to the basin; Wadi Nisah flow from the west; Ma'wan, Sha'ib As Sawt and Wadi Al Aqimi run to this basin from the south. From this basin Wadi Sahba runs to the East. This basin forms the oikoumene part of south eastern Najd. These two basins form Al Riyadh basin complex.

There is another territorial viewpoint to consider, the relative centrality of the town. Its location as a nuclear core among the component regions of the kingdom makes it weld the different administrative units.

It lies within equal distance from Al Qasim and Shammar on the north, and Al Aflaj and Al Dawasir on the south, or in other words, it lies half way between the sea-sand of Al-Nofud on the N. and the extensive sandy structure of Ar Rub' Al Khali on the south.

Also, Al Riyadh is situated in a proportionate distance between Al Ahsa on the Arab Gulf on the east, and Al Hijaz and Assir on the Red Sea, on the west.

Such well endowed position makes the town command the east west roads as well as the north south ones. Also the town is of nodal location on the axis of settlement belt in Eastern Najd, between Tuwaiq Mountains on the west and Aramah Plateau escarpments on the east.

Nowadays, Al Riyadh is vigorously advancing and so vastly flourishing that its importance outweighs all the other important towns of the Kingdom. This booming stage has been reached after oil was discovered and commercially produced in the Arab Gulf Region which is not far away from the town. Its present progress is partly due to the role which the town is undertaking as the seat of government.

2. The Geological Confines.

The town has been built on an eroded elongated depression in the Upper Jurassic deposits, mainly Arab and Jubaila Limestone formation [1].

[1] Geologic Map 1-207 A of the Northern Tuwayq Quadrangle; Kingdom of Saudi Arabia. Washington, 1958.

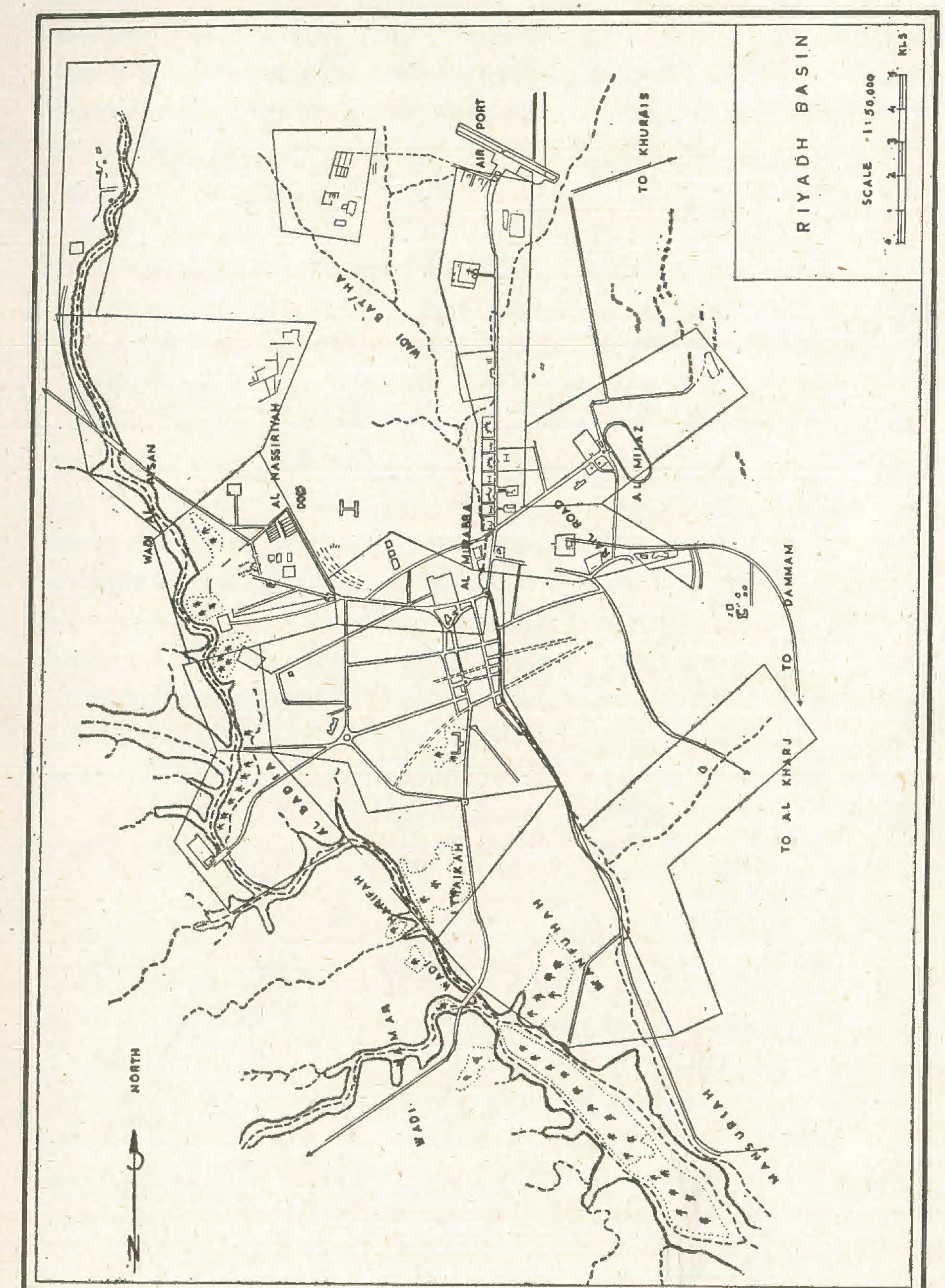

Fig. 1.

These formations include brown and tan limestone, calcarenite, and dolomite, usually distributed and in places brecciated by solution collpase. The Sold Jurassic limestone crops out in many places in and outside the town. East of the town, Lower cretaceous deposits spread, mainly of cream and tan compact limestone with infrequent thin calcarenite and coquine layers. These cretaceous deposits form some sort of escarpments, *i.e.* separated low rocky hills east of the new spreading out town.

The depression is embedded with silt, sand, gravel and other units of Quaternary age. Wadi Hanifah and its torrential feeders mainly brought the fine sediments to the depression.

Silt and sand, from the depression bed, were the only materials which the people of Al Riyadh, used to build their old time homes. Such a fact means that the old inhabitants of the town lacked the means of cutting stones from the near by rock hills to be used building materials.

The alluvial deposits in the depression made a good soil for the green belt of date grove to flourish and encompass the old walled town. Also these old deposits serve as a reservoir for the rain water to accumulate and to be kept away from being evaporated under the scorching heat of the sun in such a dry region. Thus wells dug in big houses or in every group of small houses met the limited domestic needs of the old inhabitants. These wells sunk in the depression bed are from 10 to 15 meters deep.

3. Water Resources.

The wells sunk in the depression bed, in the old houses of the old town, are diminishing in number and importance; many clay houses have been demolished to make way for the new modern buildings of western architecture. Such mansions make use of the pipes bringing water from the pumping station of Al Ha'ir. Also the water pipes knew their way to many of the old clay houses. But other wells, sunk in the depression bed, in the new Riyadh are still working by mechanical pumps to cover a part of the domestic needs of the new town, and help the water source of Al Ha'ir to meet a great part of the needs of the huge area of Modern Riyadh.

The present network of pipes that cover Al Riyadh, takes its water from two localities in Wadi Hanifah. The permeable gravel bed of this wadi is underlain by impermeable rock formation of the Upper Jurassic. A great proportion of the scanty rainfall that runs as a surface stream, sinks through the permeable gravel of the Wadi bed and is retained by the underlying impermeable rock formation. Water held in the Wadi bed is drained off by the pumping station of Al Ha'ir, 32 kms. south of Al Riyadh.

Al Ha'ir Basin is 544 metres above sea-level; so it is 50 meters lower than Al Riyadh. The sloping southward strata help to make this basin the accumulative area of the ground water of Wadi Hanifah and its tributaries north of Al Ha'ir. Wadi Hanifah reaches this basin after it has been enriched by the waters of its chief tributary Al Aysan, and its feeders, from the north; and the Wadis of Al Ammariyah, Wubair, Al Qaddiyah, Numar and Sha'ibā from the west.

The water of Al Ha'ir pumping station reaches the town through pipes of 8 inches diameter; it is stored in two huge cement reservoirs, one in Eleishah and the other in Al Shemeisy. The capacity of storage in each is 3 million gallons. The analysis of Al Ha'ir's water is as follows [1].

Ions	Units par million
Sodium	34
Calcium	83
Magnesium	38
Sulphate	150
Chloride	64
Carbonate	—
Bicarbonate	322
Total Salinity	701

These figures show that the water is quite suitable for drinking as salinity is only 701 ppm.

Such water bearing strata are very small in extent as they depend on the scanty rainfall in recent times; so they could not possibly cover,

[1] Al Riyadh Municipality: *Al Riyadh during the Reign of King Saoud.* Al-Riyadh, 1962, p. 43.

for a long time, the needs of agriculture as well as the daily consumption of water, in modern Riyadh, which is roughly estimated as 7 million gallons a day. The natural result has asserted itself; as the water drained is gradually diminishing. The amount of water has decreased from 5 million gallons a day in the first year of pumping to 2 million gallons a day in the year 1962.

The second locality of pumping is in Wadi Numar, one of the tributaries of Wadi Hanifah; the confluence of the two Wadis is at the southern end of the town. This source of water is much poorer than the former; and its daily production is nearly 1 million gallons a day. The water of Numar pumping station is stored in a huge cement reservoir in Manfuhah; its capacity is 3 million gallons. This reservoir supplies the south districts of Al Riyadh with water. The salinity of its water is not different from that of the Ha'ir.

The former two localities cannot possibly suffice the daily requirements of the modern town which is spreading out extensively. So the future of the town would be at stake, if these water bearing strata were the only source of water. They may be of considerable value to a nomadic pattern of life, but they are entirely incapable of supplying a modern town that accomodates tens of thousands of people who adopted a modern pattern of life.

The most important source of water lies in a huge reservoir, hundreds of metres thick. Water has been stored in this huge basin during former geologic epochs of rainy climates. The lower Jurassic sandstone, below Riyadh region, forms rich water bearing strata. This aquifer which is called the Minjur sandstone [1] was tackled in the year 1960. Four wells of 800 metres depth give nearly 5 million gallons a day. These deep wells which are located in different districts in Al Riyadh, are as follows : one is pierced near the military academy, the second is in Al Milaz, the third lies in Jaz'ah and the fourth is located in Al Shemeisy. Their water is more saline than that of both Al Ha'ir and Numar; the analysis of water has proved a salinity estimated at 1090 parts per million. This means that the water is still usable.

[1] The International Bank for Reconstruction and Development : *Economic Development in Saudi Arabia* (In Arabic); November 1960, pp. 30-32.

It is needless to say that these four deep wells supply the town with most of its water needs as it will be clearly seen from the forthcoming table. The Minjur aquifer which has not yet been fully used, guarantees the future requirements of the town.

The total amount of water produced from the different resources is estimated at 7.8 million gallons per day; this quantity covers the present water needs of the town. The following table shows the production of the different resources [1].

The District	Amount of water
1. Al Ha'ir Pumping Station	2,160,000 gallons per day
2. Numar Pumping Station	864,000 » » »
3. The deep well of the Military Academy	1,152,000 » » »
4. The deep well of Gaz'ah	1,728,000 » » »
5. The deep well of Al Milaz	648,000 » » »
6. The deep well of Al Shemeisy	1,296,000 » » »
Total production	7,848,000

4. Climate.

Temperature :

The chief features are the high temperature of summer, and the cold temperature of winter specially during the night. Both annual and diurnal ranges are wide. Clear skies are the main factor in developing intense heating particularly in a dry desert region.

The following table throws a light in the temperature of al Riyadh; it is the means of 10 years data, from 1952 to 1961 [2].

[1] Al Riyadh Municipality : *op. cit.*, p. 47.

[2] Kingdom of Saudi Arabia, Ministry of Defence, Department of Civil Aviation : *Meteorological Reports for the years 1952-1961.*

Monthly Av.		Mean Daily Max.		Mean Daily Min.		Diurnal range		Max. Hst		Min. Lst		Annual Range
Jan.	July	Jan.	July	Jan.	July	Jan.	July	Jan.	July	Jan.	July	
15	36	21	42	10	26	11	16	29	44	1	23	11

In winter, the average temperature is 15° C.; the mean daily maximum is 21° C., and the mean daily minimum is 10° C. These figures give a clear idea about the wide range between day and night; the days are somewhat warm, as the sun rays under a clear sky, naturally cause warmth. But the nights are very cold and the temperature usually falls to 1° C.; sometime the temperature falls below the freezing point. So it was not strange to hear that one of the soldiers who kept guard during the night was found dead of cold during the winter of 1964.

In summer, the mean daily maximum temperature rises to 42° C., and the mean daily minimum falls to 26° C. The diurnal range is very wide during this season. This fact shows that the days have very high temperature. The rays of the midday sun, beating on the barren ground, make the sand so hot that it seems to scorch even shod feet. The air is heated by conduction and a shimmaring heat haze is set up; the differential refraction in the heated layers resulting in the mirage. The Simoom, fairly frequent in this season in Al Riyadh region, laden with dense clouds of blistering sand through which it is impossible to see more than a few yards, has a very bad effect on the inhabitants, particularly on foreigners. The nights are distinctly cool; after sunset the heat is quickly lost by radiation and the temperature falls rapidly.

The summer type of climate reflects its bearings on man, plant, and buildings. The type of clothes, dressed by the Arabs, has its relationship to the prevailing weather. The wide dress (Al Jalabiah) helps ventilating the body and lessening the amount of perspiration. Those who are dressed in western clothes would greatly appreciate the more convenient Arab dress. The head dress (the Ghutra) helps to shade the head and protect the face from the scorching sandy winds.

The old clay buildings were designed within the sphere of this type of climate. Windows are restricted to very narrow openings in the walls either circular or rectangular. Such a device would keep the rooms cool and free from the scorching heat outside. Also the sun dried bricks are more suitable than the cement bricks in the modern buildings as they do not absorb the heat of the sun.

The high temperature is a great strain on the nerves of the inhabitants who feel as if strangled by it; so they could not but sleep in the open during the night; they either sleep on their house roofs or go outside the town and sleep in the cafées scattered around the town in the open air. The green carpet of coarse grass in gardens or in patches around the town became parched, brown and brittle, so that it is blown away by the wind.

It may be useful to note the contrast with other towns such as Jiddah and Cairo. Jiddah which enjoys the tempering influence of the sea, has a warm winter and the temperature rarely falls down to 18° C. Also in summer, the weather is temperate, and the temperature rarely rises above 38° C. Cairo which is far away from the sea, has a mean daily minimum in January 17° C.; thus it is much warmer than Riyadh. In summer, the mean daily maximum is 36° C. The wide difference between the two towns ascertains the desert type climate of Al Riyadh.

Humidity is generally low, but a marked increase occurs in winter. Low humidity together with high temperature in summer makes living conditions bearable. If the high temperature in summer were accompanied by high humidity, life would be extremely unpleasant. The mean relative humidity in January is 54 per cent, but in July it falls down to 17%, and the lowest minimum is only 6%. These figures show the dryness of the desert climate of Al Riyadh Region.

The prevailing winds are the north and north western winds; the south and south-east winds are of a few occurrences.

Rainfall is exceedingly variable in amount from year to year. The rainfall in 1952 was 6 mm., but the amount of rains rose the following year 1953 to 227 mm. The mean annual rainfall is 26 mm. The rainy season begins in November and ends in May; February and March are the rainiest months. A great deal of rain may fall in a short time, 25 mm. per hour is by no means unusual; but during the rest of the month, the sky is clear and rainless.

Historical Evolution :

In the 13th century, Yakut Al Hamawy does not mention Al Riyadh in his book «Mojam Al Buldan»; perhaps it was such a small hamlet that it could not draw his attention. Niebhur [1], in the 18th century, did not write about it when he was numerating the villages of Najd. The big oasis villages overshadowed the very small ones of which Al Riyadh was one.

Manfuhah which is only now a small suburb of Al Riyadh was a village of considerable size that impressed the Arab and European writers because of the leadings part it was playing at that time. Al Dir'iyah which was an important village too was a strong rival to Manfuhah; and each of them waged war against each other. Al Riyadh which is situated between these two powerful villages, came frequently under the military sphere of either of them.

The Arab historian of Najd, Othman Bin Bishr [2] states that Al Riyadh which was governed by Diham bin Dawas, was annexed to the dominions of Al Saouds the rulers of Al Dir'iyah in the year 1187 H., 1773 A.D. After the destruction of Al Dir'iyah by the armies of Mohammad Ali in the year 1818, Al Saouds, after recovering from the disaster that befell them, regained their power under the leadership of Al Imam Turki bin Abdallah and settled in Al Riyadh which superseded Al Dir'iyah as their seat of power in the year 1240 H. [3] 1824 A.D. From this year on, Al Riyadh played the most important role in the history of the Arab Peninsula.

The spatial evolution of the town may be divided into three stages (Fig. 2):

A. During the nineteenth century.

B. The first half of the twentieth century.

C. The modern Riyadh.

(1) NIEBUHR, M., *Description de L'Arabie*. Paris, 1779, tome II, p. 203.

(2) OTHMAN BIN BISHR; *Onwan Al Majd fi Tareekh Najd*. «The Guide of Pride in the History of Najd». Al Riyadh, 1373 H., vol. I, p. 69.

(3) OTHMAN BIN BISHR; *op. cit.*, vol. II, p. 18.

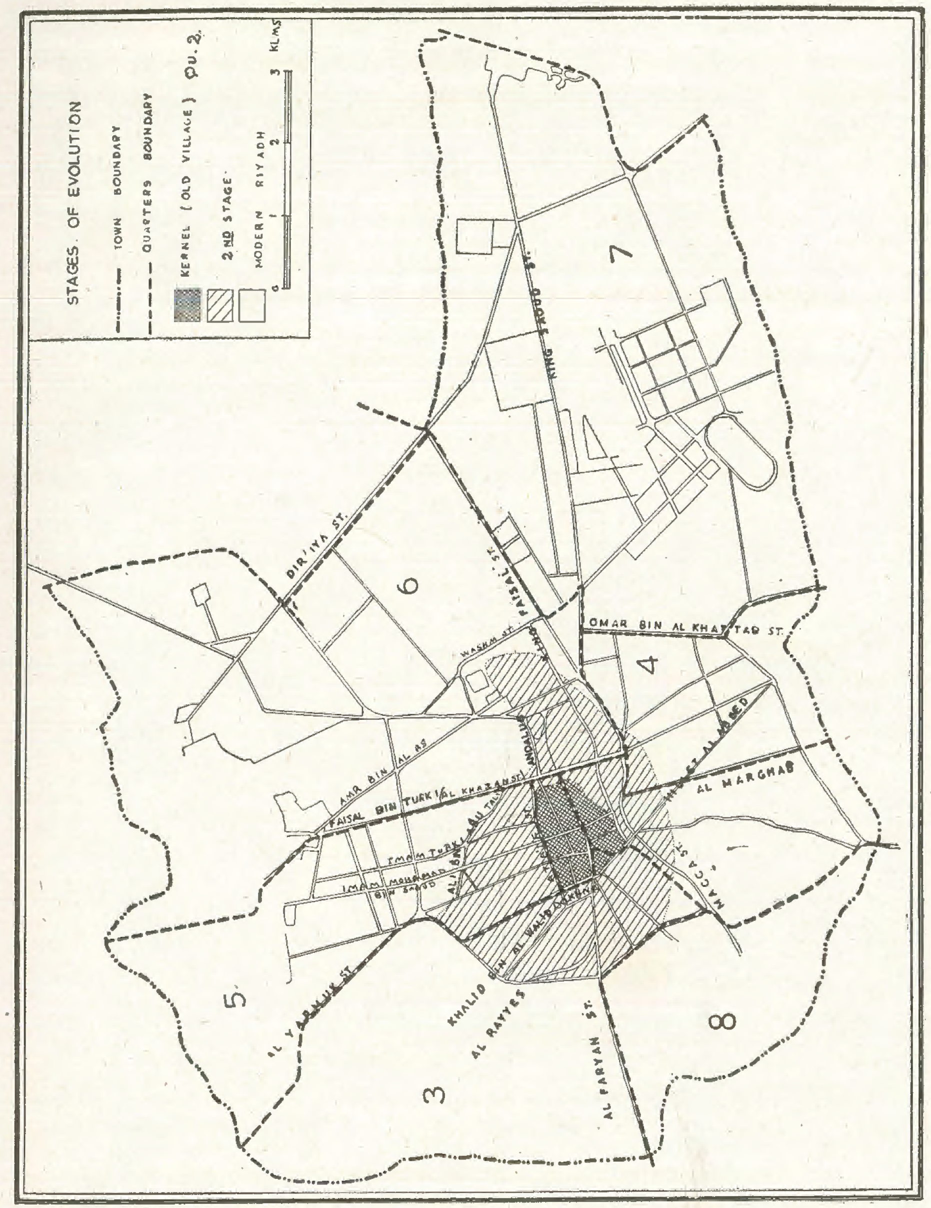

Fig. 2.

A. *Al Riyadh in the nineteenth century :*

The old village of Al Riyadh is the nucleus round which the modern town has been extending in all directions after the fortified walls had been demolished.

One of the aged inhabitants recounted that the walls were built by Nassir Bin Hamid Bin Nasser Al A'ezi, the governor of the town during the Turkish rule after the conquest of Najd by Ibrahim Pasha. The walls, according to his description, were located as follows :

The south walls were erected south of the present Dokhna square; on the east, the walls were parallel to the street of King Faisal; on the north, they were bounded by Al Mousimiah and Al Azzawiah districts which lie south to Al Khazan Street; in the west, the walls were close to the present Al Ata'if Street. Thus, the village extended 1125 metres from north to south and 750 metres from east to west. It had a rectangular shape.

This description of the walls is not far from the truth, because the old cemeteries which are still existing, but abandoned, may be considered as the signposts that give the true boundaries of the old walled village. These burial places which are close to the demolished walls are : Shalka on the north east, Jabrah on the south east, Abu Al Habag on the north, Al Megebrah on the south.

The perimeter of the walls was pierced by bastioned gates that served as an outlet to the walled palm groves encircling the village. No information was given about the right number of the gates, but the aged teller presumed that the gates might be four in number corresponding to the main four points of the compass; the northern gate led to the track of Al Qasim, the southern one faced Manfuhah, the eastern served the track to Al Ahsa, and the western gate led to Al Hijaz.

Lorimer [1], in his Gazetteer of the Persian Gulf recounted that the town had six gates, and its inhabitants amounted to 8000 souls.

The village embraced both settled and semi-settled patterns of life as the inhabitants who were clans from Onaizah and Tammim tribes,

[1] LORIMER, J.G., *Gazetteer of the Persian Gulf,* vol. II, Calcutta, 1908, p. 1592.

depended for their sustenance upon agriculture as well as on grazing in the surrounding tribal areas. Some of the descendants of these clans such as Al Bou Shams, Al Rayis, Al Shashat and Al Zara'a, are still living in Al Riyadh.

The most eminent feature of the morphology of the village is the central enclave embracing a cropping out limestone rock more elevated than the surrounding clay houses. This limestone platform which shelves down on all sides is called Al Safat. To the north of this enclave lies the great mosque, and the market which presents the commercial core in the village, to the south, Al Saud's palace was erected. The palace accomodated the administrative departments. This district centre includes the central services required by such inhabitants of primitive needs : mosque, shops and the governor's offices.

A wide street crossed the village from east to west passing through the central enclave and dividing the village into two sections; the southern one was twice as much as the northern section. The residential area which enclosed the central district was occupied congregationally by the different clans of tribes. The lanes which were very narrow, converge to the central core from the farther ends of the village.

Palgrave's description, after his controversial visit to Al Riyadh in the year 1862, differs in many points from the previously stated description.

Palgrave [1] claims that Al Riyadh is of square shape with two main streets, one running from north to south and the other extending from east to west. The two arteries intersected in the central square and divided the village into four distinctive quarters. In the north east quarter lived the royal family and other rich families. The south west division was occupied by the descendents of Al Sheikh, the religious leaders. In the north west section resided the political and religious outcasts. The last quarter was reserved for the poor families (Fig. 3).

Any one who knows about Islamic principles and the tribal inherited traditions that admits of no racial or social distinctions, will never believe that the religious society in that primitive village was living in segregated

[1] PALGRAVE, W.G., *Une année de voyage dans l'Arabie Centrale 1862-1863.* Paris 1866, tome second, pp. 47-49.

segments. From the economic view point, there was no wide difference among the inhabitants who discharge agricultural and pastoral tasks. Certainly there were poor labourers who were either of tribal descent or slaves; the former lived in the neighbourhood of their kinsmen, the

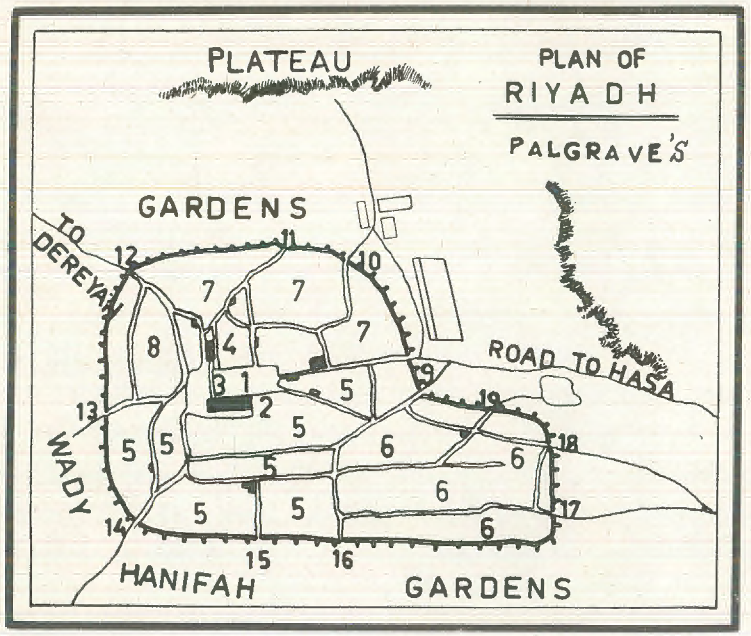

Fig. 3.

1. — Market.
2. — Faisal's places.
3. — Covered gallery.
4. — Mosque.
5. — Al Cheikh quarter.
6. — Poor class quart.
7. — Religious dissidents quarter.
8. — Royal quarter.
9. — Principal gate.
10-19. — Other gates.

latter lived with their masters or near them. The presence of any political or religious outcasts could not be conceived as there were neither political parties nor different religious sects. In a narrow scaled society such as Al Riyadh, the rich and poor lived side by side. The people too, had to live in complete unity as their strength lay in their unity; in such case they will be able to defend themselves against the attacks of their enemies and they could wage war against neighbours and acquire booty.

Thus, Palgrave's description of Al Riyadh and its four quarters does not apply to that village in the nineteenth century.

B. *The first half of the Twentieth Century :*

For three decades, Al Riyadh did not see any radical changes; the kernel and the integuments were still within the old fortified walls. The only changes that could be observed, were related to the walls and gateways.

The old walls and their fortifications, particularly the north and east sides which were demolished by Ibn Al Rasheed at the end of the nineteenth century, were rebuilt by King Abd El Aziz Al Saoud after he had recaptured Al Riyadh after 1902.

Philby who visited Al Riyadh in the year 1917, gave the following description of the walls and gateways after they had been rebuilt [1].

« The city is completely encircled by a thick wall of coarse sun-backed mud-bricks, about twenty five feet in height and surrounded by a fringe of plain sharks' teeth design; at frequent intervals its continuity is interrupted by imposing bastions and less pretentions guard-turrets, circular for the most part and slightly tapering towards the top but some few square or rectangular, varying from thirty to forty feet in height and generally projecting slightly outwards from the wall line for greater facility of defence».

He also states that the walls were pierced in nine places by gateways; the most important were, the Thumairi on the east, the Dhuhaira and Shamsiyah on the north, the Bud'ia and Muraigib on the west, the Dokhna on the south. The chief street ran from Al Thumairi on the east side to Al Bud'ia on the west side through the central enclave, and there was a branch going off from it at right angles to al Dhaihaira gate on the north side. Other narrow streets led from the central enclave to the other gate ways (Fig. 4).

Philby roughly reckoned the superficial area of the village as 100 acres; but according to the recent map of Al Riyadh, the area of the old village amounts to 200 acres or less than one square kilometre.

Philby's plan of Al Riyadh is, to a great extent, inapplicable to the town of 1917, because it gave the town a triangular shape of so many

[1] Philby, H., St. J.B., *The Heart of Arabia.* London, 1922, vol. I, pp. 70-72.

dental sides. If one asks why the people of Al Riyadh exerted themselves and erected so many sided walls as there are no geographical hindrances that would oblige them to increase their hardlabour and build these denticular walls, no satisfactory explanation would be given. Philby

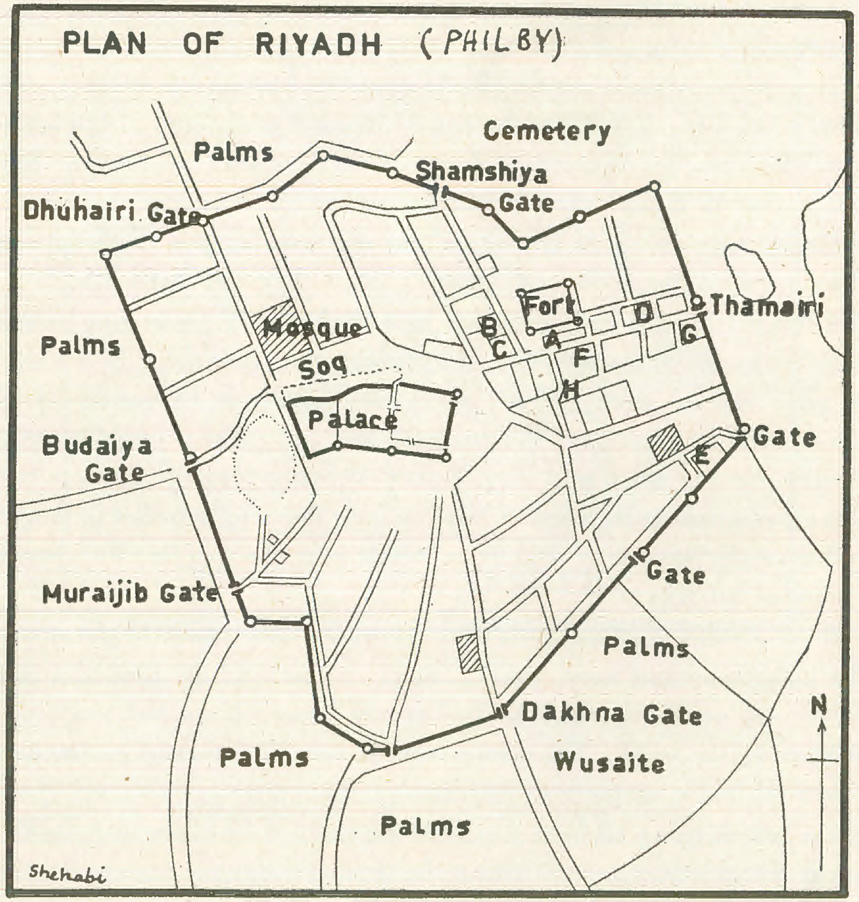

Fig. 4.

in that remote time, as one thinks, lacked the accurate means of drawing the right plan of Al Riyadh. The information given by the aged people of Al Riyadh proved that the old walls of the village were nearly straight.

Al Rihani [1] who visited Al Riyadh later added nothing new.

[1] Rihani, A., *Ibn Saoud of Arabia.* London, 1928, pp. 126-132.

After the year 1930, the process of change began, as Al Riyadh was gradually transformed into townscape with urban development. After King Abd El Aziz had ended his campaigns for the conquest and unification of the regions that formed his kingdom, peace and security spread every where his realm. Thus the people of Riyadh no longer sought security in walls; in the meantime they felt sure that concentration of habitation within the fortified walls in spite of their natural increase in number would make them suffer diseases because of lack of sanitation. So the walls succumbed to the pressure of the advancing masons and were levelled to the ground.

All around the fortified walls of Al Riyadh, except towards the north east where the cemetery of Shalka is located, lay the dense palm groves and gardens. The big gardens had famous names that are still existing as names of districts in the modern town. Al Wusaita palm grove lay to south east side, Al Shamsiyah and Al Hautah palm groves lay to the north side, Al Badia palm grove extended to the west side and Al Feryan palm grove to the south side.

This green belt which, once encompassed the old village, was sacrificed to provide an ample area for the substantial extension of the new town. King Abd El Aziz moved out of the old village into a new castellated palace called Al Murabba (Quadrangle) $1\frac{1}{2}$ klms. to the north of the old walls in the year 1938. On the east bank of Al Bat'ha channel, a large suburb was growing up to meet the needs of a new element of the population, the drivers and mechanics from different Moslim countries to look after the royal garage in the same suburb, as well as the other motor cars and lorries owned by the rich people of Al Riyadh.

The members of the royal family, the indigenous elements and the immigrants from other parts of the kingdom built their homes around the demolished walls. So the expansion of the town went in all directions. The most important point is that the expanding town continued to preserve the character of the core; *i.e.* the houses were built of clay and after the traditional architecture of the old village. This will make a wide difference between the town expansion before the year 1950 and after. The expansion after the year 1950 is distinctive because it has mostly been modelled after western architectural designs.

The Kernel expansion, in the second stage, covered an area nine times as much the old walled village; the extension is 3.5 klms. from north to south and 2.6 klms. from east to west.

Al Murabba palace presents the farthermost northern extension, the palace of Abd Allah ibn Abd Al Rahman, the brother of the late King Abd El Aziz is the southern limit. The extension eastward is about three quarters of a kilometer east of the torrent bed of Wadi Al Bat'ha; where the suburbs of Hillet Al Abeed, Hillet Al Kosman (relating to Al Qasim), and Hillet Al Kuwaitieh have been built. In these suburbs the residential areas are intermingling with the workshops and commercial shops. The western expansion towards Wadi Hanifah is extensive.

If the expansion in this stage is applied to the present map of Al Riyadh, the streets that limit the extension will be as follows : the street of Al Washm on the north, the streets of Al Andalus and Ali Ibn Abi Taleb on the west; the intersection of Hillet Al Abeed and Al Margab denotes the eastern limitation of the expansion; the palm groves of Al Rayyis and Al Faryan, and the palace of Abd Allah Ibn Abd El Rahman on the south.

The expansion as a whole took the shape of an irregular squared figure if the node of Al Murabba is excluded. That is because the rocky tableland of Zahrat Al Wisham to the east of it, blocked the expansion of buildings in that direction, also to the west of Al Murabba, there was an unoccupied area that did not attract people to dwell in, at least in that epoch. Therefore, if Al Murabba is included, the expansion took the shape of a rough triangular figure.

On the whole, the outward extension of the town formed a ring round the kernel.

The kernel has undergone a fine degree of readjustment to a complex variety of considerations, so the internal changes were very necessary to adapt the old forms to new uses. Replacement of old buildings by new ones, specially constructed for new functions has been in process. The Old palace, near the central enclave, was levelled to the ground, and replaced by a huge building housing the law-courts, the offices of the governor of Al Riyadh province, and spacious audience chambers for the use of the King on ceremonial occasions. The great mosque too, in its vicinity, and a large area of houses around it were demolished, and in their place arose the new mosque with its two tall minarets and graceful colonnades.

The houses bordering the crooked narrow streets and lanes were demolished to give place to new wide tarmac streets suitable for motor traffic. Modern shops lined the new streets radiating from the central enclave in every direction. So the residential belt in the kernel was invaded by the expanding commercial core and other central services.

C. *Modern Riyadh :*

The year 1950, was the dawn of prosperity in the kingdom. The oil had, of course, been found in Al Ahsa, but its exploitation had been severely limited by the requirements of allied war policy. It was not until 1950 that the first substantial dividends were to find their way into the kingdom's treasury. The following year, the royalties were double the previous year, and the dividends have been steadily increasing year after year. The following table clarifies the economic status before 1950 and after it.

Year	The income from oil in million dollars
1946	10.4
1950	56.7
1951	113.6
1952	210.7

So, it is needless to say that the economic status has been greatly improved, and the wealth derived from oil has created a desire for comfort among the people of Al Riyadh, so they have become accustomed to build luxurious villas and mansions in far away suburbs. The motor car is a powerful agent in the process of change in the modern Riyadh.

The railway between Al Dammam on the Arab Gulf and Al Riyadh began to operate in October 1951. Thus, the economic position in Al Riyadh has been improved out of all recognition by the drop in the cost of transport of all essential commodities. The railroad had transported hundreds of thousands of tons of cement, steel, tile, marble for the construction of modern office buildings, up to date apartment

houses, family residences as well as power and water plants. This material was followed by electrical equipment, sanitation and plumbing supplies, roofing materials and the hundreds of various items which enter into the demand of today's architecture. The impact of the modern railroad upon the ancient inland town, Al Riyadh has been one of the important factors in the modernization of the town.

The new paved roads which connect Al Riyadh with the other important centres in the kingdom have accelerated the growth of the town as the motor transport on these roads attracted the indigenous elements from the other regions of the kingdom as well as visitors from all parts of the world in such numbers as to outstrip the capacity of the traditional guest rite arrangements. To provide accommodation for them, hotels, restaurants, and other facilities have come into being. It is needless to say that the air traffic has added to the urbanization of the town.

In the year 1957, government offices have been transferred from Jiddah to Al Riyadh. Thousands of buildings have been constructed to accommodate the new comers. The size of the central services, commercial business and manufacturing activities has increased to cover the needs of the new society.

If Griffith Taylor's viewpoint about the stages of growth of towns is to be considered, Al Riyadh definitely passed the third stage of adolescence and is on its way to early maturity.

After considering the important factors that have led to the later growth and modernization of Al Riyadh, the axes that controlled the chief extension of buildings should be dealt with. Al Riyadh extends 12 klms. from north to south and 8 klms. from east to west; it covers superficial area of 96 square kls. The paved roads from certain locations to the kernel are the chief axes along which the expansion has taken place. On the north, the airport 9 klms. far from the kernel, determines the northward extension; on the east the railway station and the horse racing field (Al Milaz) 4.4 klms. from the kernel, orient the extension. Wadi Hanifah and Badia Palace 3.6 klms., control the extension to the west. Al Mansuriah Palace (related to Prince Mansour, King Saoud's son 12.5 klms. and Manfuhah lead the expansion to the south. These locations contribute to the orientation of the outer growth of Al Riyadh which in this stage, takes nearly a lobster like shape.

The extension takes three phases; firstly the buildings that align the former paved roads and thoroughfares; secondly the residential suburbs that have sprung adjacent to some of the former locations; thirdly the infilling of the void spaces.

1. *First type extension.*

Government offices, hospitals, hotels, and institutions align the road leading to the airport. Administrative offices, schools, nursing homes, the university and residential buildings align the road leading to the race course (Al Milaz). Manufacturing shops, and some industrial plants were built on the road leading to the railway station. Dwellings run parallel to the road leading to Nasiriyah Palace.

2. *Second type of expansion.*

The suburb of Al Riyadh Al Jadidah (the New Riyadh) is a huge residential area where the officials of the ministries recently transferred from Jiddah live. This new suburb lies adjacent to the race course (Al Milaz). Shopping and central services are among the tracts of housing.

The royal Quarter forms a magnificent residential suburb around the Nasiriyah Palace. Mansions and estates face wide roads of dual carriageway, divided by an island of flower beds.

On the southern outskirts of Al Riyadh lies the big residential suburb of Al Badiyah town where the Bedouins live.

Westward expansion to Wadi Hanifah takes the form of a peripheral growth to the west of the kernel; there are clusters of homes interpersed with open spaces.

3. *Third type Growth.*

Apartment buildings and villas that have been built or in the process of construction are filling in the breaks in the continuity of the built up area; so a long time will not be elapsed before the agglomeration and coalescene of the separate nuclei will come to existence.

The kernel and the surrounding integuments have undergone many changes. Many old clay houses were demolished to give way either to

wide straight streets that tie the outskirts with the central core, or for new business premises. The commercial core has spread beyond the limits of the kernel; the modern shops lining the new streets form the extended arms of the commercial business in the old town.

The modern Riyadh has taken the full urban status, there exists the group of services necessary for urbanized life. Shopping centres with a full range of specialized retail services, health services such as hospitals, nursing homes and private clinics, educational services such as, secondary schools, technical institutions, public libraries, higher schools of engineering and teaching, the University with its four faculties, colleges dealing with the Arabic language and Islamic legislation under the supervision of Al Sheikh, all of these services are localized in different parts of the town. Also football fields with grandstands, recreational centres, such as the Zoo and public gardens, accommodation facilities such as first class hotels and restaurants. All these services have come to being. The network of water pipes and the gigantic electric plant were among the requirements of the modern town that have been introduced.

Physiognomical Aspects.

The town is geographically divided into eight administrative quarters; the central core forms the nucleus quarter off which branch three quarters extending to the west, east and south west. The further suburbs make the other four peripheral quarters. These quarters are characteristically different in their morphological and functional structure.

I. — THE CORE [1].

The core embraces most of the old walled village, or the kernel; it is confined on the east by the street of Al Zahirah, on the west by Al Atayef

[1] The following description and analysis of the core and the other quarters is the result of an intensive personal field survey.

Street, on the north by the street of Al Khazzan, on the south by Dokhna district. It has undergone drastic changes by potent centrifugal and centripetal processes and the concomitant internal re-arrangement and re-adjustment. The core has admittedly been reshaped to keep pace with the broadening out prosperous town.

The central enclave is still the square of Al Safat, but greatly enlarged with flower bedded parks in the centre. Many wide paved roads branch off from this central enclave in every direction, so the old clay houses were sacrificed to the benefit of the new arrangement. The most salient feature is the entourage of the square, the great rebuilt mosque on the north, the administrative and local government buildings comprising the Principality of Al Riyadh and the royal audience chambers on the south. Four sectors make up the core. The native old market in the middle, the administrative offices and law courts amidst the market area, the modern market on the east and north; the old and new residential area contiguous to and enclosing the markets.

(a) *The native old market.*

On a grid pattern, every trade is allocated a special block. In the extreme south west of the market stands the green grocery and fruit market; butchers quarters occupy the Juxtaposition. To the south east stands the cloth market and nearby the crockery and house utensils market to have their stand. Cashiers occupy the south side of the central enclave. On the west of the market the tea, coffee and spices market lie contiguous to the wholesale market. The auction sale market (Al Harag) occupies the northern part of the market and the carpet market is close to it.

(b) *The modern market.*

The modern shops line the wide streets of the core, especially those on the north and east of the core, in a specialised pattern. The big stores with different departments specially clothes and cosmetics occupy the eastern part of the core; electric equipments extend to the south east

of the central enclave. The commercial shops and agencies in both markets amount to 1714 in number, and they occupy 501 buildings equal to 26% of the total buildings [1].

(c) *Administrative buildings.*

Amid the market area and surrounding it, the administrative buildings such as the principality of Al Riyadh, Passport offices, law courts, the committee of « Al Amr Bil Ma'arouf Wal Nahy an Al Monkar» inducement to do good and avoiding the evil doings, are all Juxtaposed.

(d) *The residential area.*

The buildings of the residential area represent 74% of the total buildings in the core; the rest is occupied by the establishments of commercial activities. In spite of the many houses that were raised down to earth, the old clay houses with narrow lanes are still the dominant feature, and they form 86% of the total buildings of the core. The new buildings built of cement blocks on modern basis of architecture only represent 14% of the total buildings. The ratio of families housed in clay buildings to those living in cement modern architectural houses is 5 : 1. The dwellings and the commercial shops intermingle in the market area; this intrusive feature shows obvious signs of residential deterioration in the central part of the core. The other residential areas enclose the market area. Private clinics and pharmacies tend to be scattered with the residential area.

The majority of the old conservative families living in old clay houses sensed the importance and convenience of using the new modern devices so they installed the water and electricity supplied by the municipality. Only 210 houses out of 1228, that have not enjoyed the advantages of utilising the water and electricity services; 880 dwellings have water and electricity facilities, 51 houses have only water, 87 houses have

[1] Ministry of Finance : *Report on Population and Establishments in Al Riyadh* (in Arabic). Al Riyadh, 1963.

N.B. — The different figures concerning the population and buildings in the different quarters are taken from the previous report.

only electricity. These aspects reveal an important geographical feature, the fanatic people of the old Riyadh who were strictly against the introduction of the new modern devices, have changed their opinion and began to give up the old ideas and welcome the economic and social changes in order to keep pace with other progressive countries.

II. — THE INTEGUMENTS.

1. Quarter one.

This administrative quarter lies to the east of the core and includes the eastern part of the kernel with the addition of the new suburbs of Hillet Al Abeed and Al Margub; moreover it extends to the extreme east end of the town where the road to Al Kharj marks the eastern boundaries of Al Riyadh. This integument is bounded by Al Zahirah street and King Faisal Street on the west, Al Imam Faisal and Al Imam Abd El-Rahman Bin Faisal on the north, the quarters 3 and 8 on the south.

Two sectors make up this quarter. The eastern part of the kernel on the west bank of Al Bat'ha and the outer expansion on its eastern bank.

(a) *The Eastern part of the kernel.*

Two outstanding features are apparent in this portion of the kernel : firstly, the old clay houses transversed by very narrow zigzag lanes around the gigantic palace of Al Masmac which was built of clay by Abd Allah Bin Faisal Bin Turki at the end of the nineteenth century, this huge castle commemorates the triumph of King Abd El Aziz at the conquest of Al Riyadh in the year 1902 and secondly, the new apartment buildings and houses of western architecture which line the new paved wide roads, and hide behind them the former old houses. This subdivision consists of the modern market and the residential areas.

The market is the eastern extension of the commercial core; the trades are not allocated after a specialized pattern, modern groceries stand by the stores of cloths and ready made clothes, and those lie adjacently to electric equipment shops, furniture stores and hairdressers and bookshops. These shops line the streets of Al Thumairi and King

Faisal; Syrians, Lebanese, Palestenians dominate many trades, especially groceries and the craft of hair-dressing, carpentry, butchering and bakery. To the east, a bloc is occupied by carpentries. Private clinics, pharmacies, banks, commercial agencies and other key services are linked in function to the market (fig. 5).

The residential area comprises the old clay houses and the new dwellings of western architecture; the clay houses are situated to the west of the new apartment buildings lining King Faisal Street. The new residential belt intermingle with the new modern commercial premises and some of the new blocks lie to the west of King Faisal Street.

(b) *The eastern outer expansion.*

The majority of the buildings, in these suburbs (Hillet Al Abeed and Al Margab) are built of clay during the first half of the twentieth century; moreover the architecture adhered to the old traditional pattern, only the buildings which mostly take the form of apartments, have been recently built on the eastern bank of Al Bat'ha or King Saoud Street. Big stores, travel agencies, hotels, schools, pharmacies bookshops concentrate in the modern residential area. The old residential area, which stands to the east of the modern buildings, embraces a limited number of commercial premises.

Three cemeteries are located in this quarter, but they are now abandoned, the biggest and the oldest is Shalqa cemetery extending to the west of King Faisal Street, the second lies towards east of the former street, the third extends in the suburbs of Hillet Al Abeed.

The residential buildings of this quarter represent 84% of the total buildings, the rest is occupied by establishments of commercial activities. This percentage nearly agrees with the ratio of clay buildings to modern cement buildings, *i.e.* the commercial establishments are totally housed in modern new buildings. In general the number of buildings is more than twice as big as the core, but the number of the commercial premises is far less than the core.

The number of dwellings and premises supplied with water and electricity is equal to those which do not utilise these facilities.

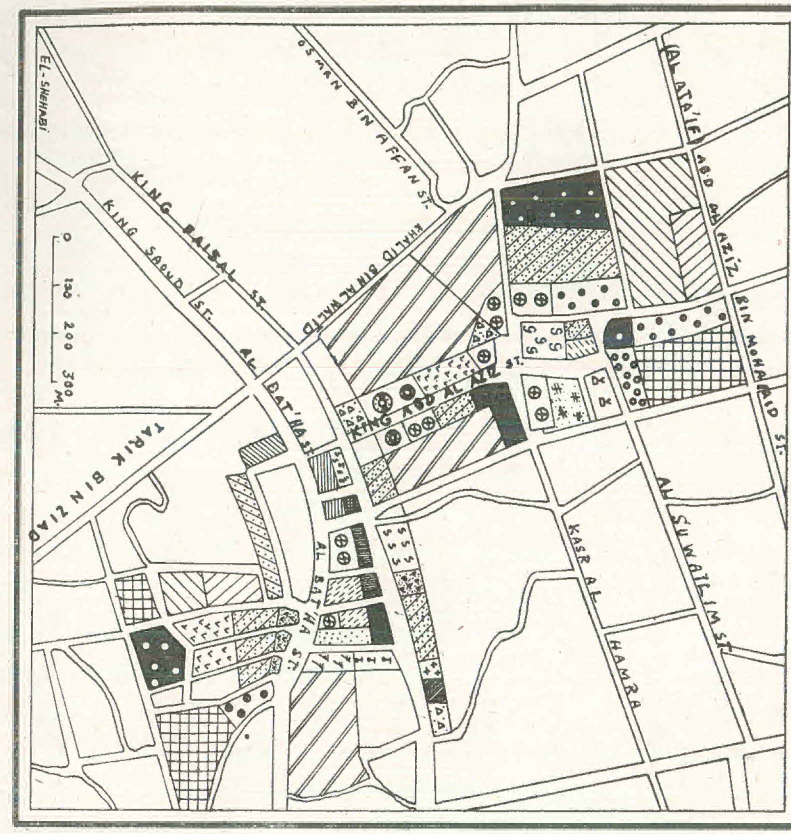

Fig. 5.

GREEN GROCERIES
BUTCHERS
GRAIN DEALERS
BAKERY & RESTAUPANTS
MODERN GROCERIES
GROCERIES
TEA, COFFEE & SPICES
WHOLESALE MARKET
MOTOR CAR SPARE PARTS
CLOTH & READY MADE CLS.
TAILORS
STORES
HOUSE UTENSILS & CROCKERY
LIBRARIES
FURNITURE
SANITARY EQUIPMENTS
ELECTRIC "
WATCHES
JEWELPY & GOLDSMITH
HAIRDPESSERS
CARPENTRIES
WORKSHOPS
BANKS
CASHIERS
PHARMACIES
CARPETS & AUCTION SALE
VARIOUS KINDS OF TRADES
GOVERNMENT BUILDINGS
MOSQUE
RESIDENTIAL AREA

2. Quarter Four.

This quarter lies to the east of Al Bat'ha bank and is confined by : Omar bin Al Khattab Street on the north, Abd Al Rahman bin Faisal on the south and the road of Al Kharj on the east. Its characteristics make it individually distinct among the other quarters. The areal allocation of the different sectors is conspicuous. Three sectors make up this quarter : the market, the central station of motor cars and their mechanic engineering business, and the residential area.

The market : The forefront of the market which faces Al Bat'ha bed (King Saoud Street) is made up of modern buildings the ground floors of which are mostly occupied by commercial premises. The native market where every trade is allocated, a special block extends adjacently eastward of the former belt. It is named Al Kuweitieh market (Market of Kuwait).

The market is the extension of the commercial centre in the core and its branch in the former quarter. The native market is characterized by exclusive minute specialization : cotton and silk cloth trade and ready made clothes occupy the eastern block in the market; tailors are Juxtaposed. Crockery trade, specially the old traditional utensils, lies to the east of the first block. Amidst the two trades, carpet trade has its place. Spices and grain dealers occupy the northern part of the market. Butchers, green grocers, date traders, and herbage dealers are all Juxtaposed.

The Industrial Sector : The central motor car and bus station is located on the north sector of this quarter; it is the terminal station for all roads coming from different parts of the kingdom : from Jiddah, Mecca, and Al Madinah in Al Hijaz, from Al Dhahran and Al Hofuf in the eastern province, from Al Qassim on the north, and from Al Aflag on the south. In the environs of this station lie all spare parts shops and mechanical engineering workshops. Also in this sector (Hillet Al Ghorabi) used motor cars are exhibited and the exhibition parks occupy a large area. Establishments both commercial and industrial outnumber those in the core or in quarter I; they count 2131 which is nearly equal to both premises in the core and quarter I. This shows that commercial activities

and key services spread out from the core to the former quarter in order to meet the increasing needs of the flourishing town.

The Residential Area : In the market and industrial areas, houses intermingle with the commercial premises and workshops to the east of these commercial and industrial areas, the residential area forms an extensive block. On the extreme east huts and tents spread dispersively to house the poor immigrant Bedouins.

The majority of buildings, as they are mostly the product of the first expansion, are built of clay and represent 81% of the total buildings while the modern new houses are only 12% of the total, the huts and tents constitute the rest (fig. 6).

The buildings supplied with water and electricity facilities, in this quarter, are 56% of the total buildings; those which are deprived of these facilities are 27%; some of the buildings are connected with only waterpipes, others are only wired for electricity, they are successively 10%, 6%. This shows that utilization of water and electricity facilities is spreading fast in this desert town (Fig. 7).

3. Quarter Five.

This quarter extends from the core westward to Wadi Hanifah; it is confined by Al Atayif street on the east, Al Khazzan Street on the north, Al Kura and Al Badiyah Streets (Khalid bin Al Walid Street and Al Yarmūk Street) on the south.

Two sectors make up this quarter; the eastern sector, limited by Al Shemeisy Hospital Street (Al Imam Abd El Aziz bin Mohammad Street) on the west, represents a connected block of residential area with mainly clay buildings and clusters of commercial premises. The western sector which forms the outer margin of expansion, is a residential belt of modern buildings modelled on western patterns with void spaces in between.

The clay buildings of this quarter make 89.5% of the total buildings; only 9% is built of cement blocks, the huts and tents of the poor Bedouins exist at the periphery and form 1.5% of the total.

Buildings enjoying these facilities are 60% of the total, while the percentage not connected with the water and electric plants is 23%.

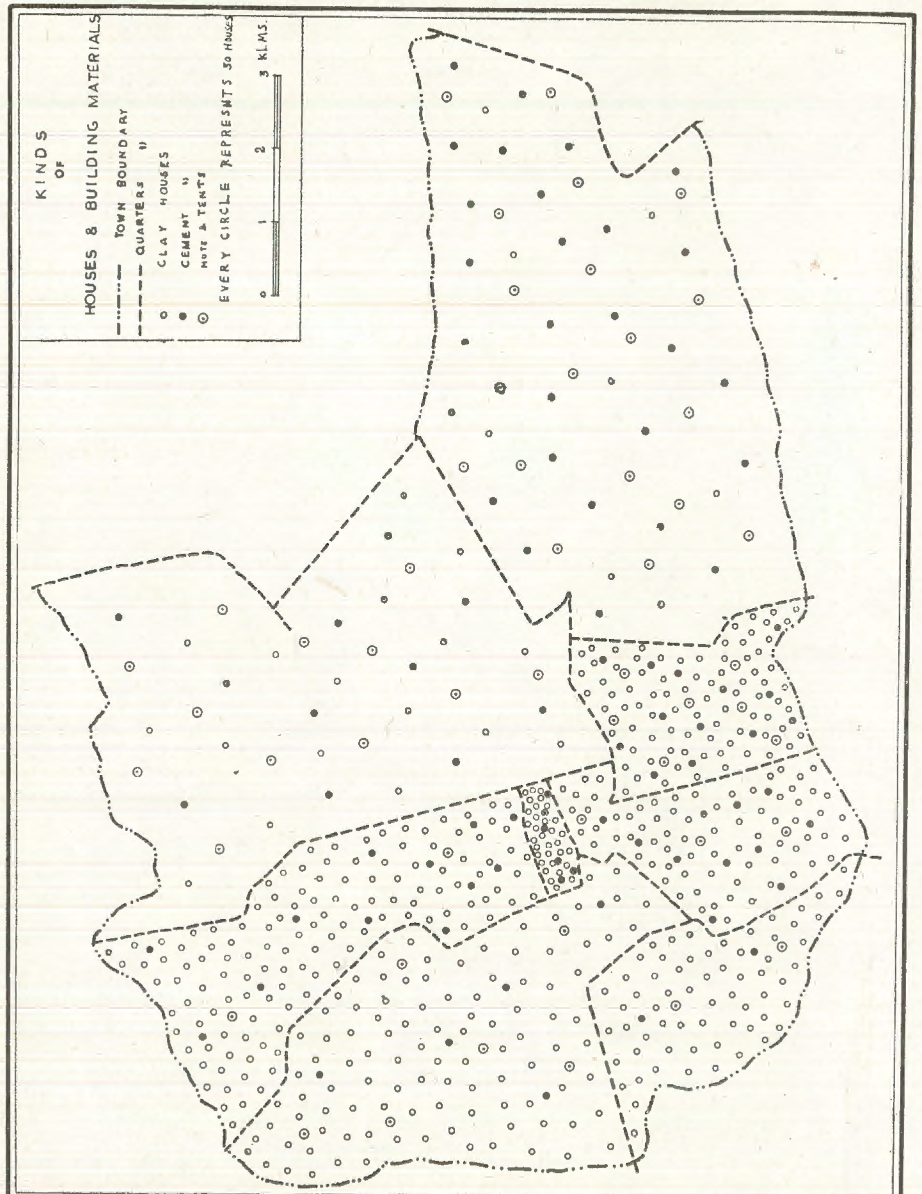
KINDS
OF
HOUSES & BUILDING MATERIALS
TOWN BOUNDARY
QUARTERS "
CLAY HOUSES
CEMENT "
HUTS & TENTS
EVERY CIRCLE REPRESENTS 50 HOUSES
0
1
2
3 KLMS.

FIG. 6.

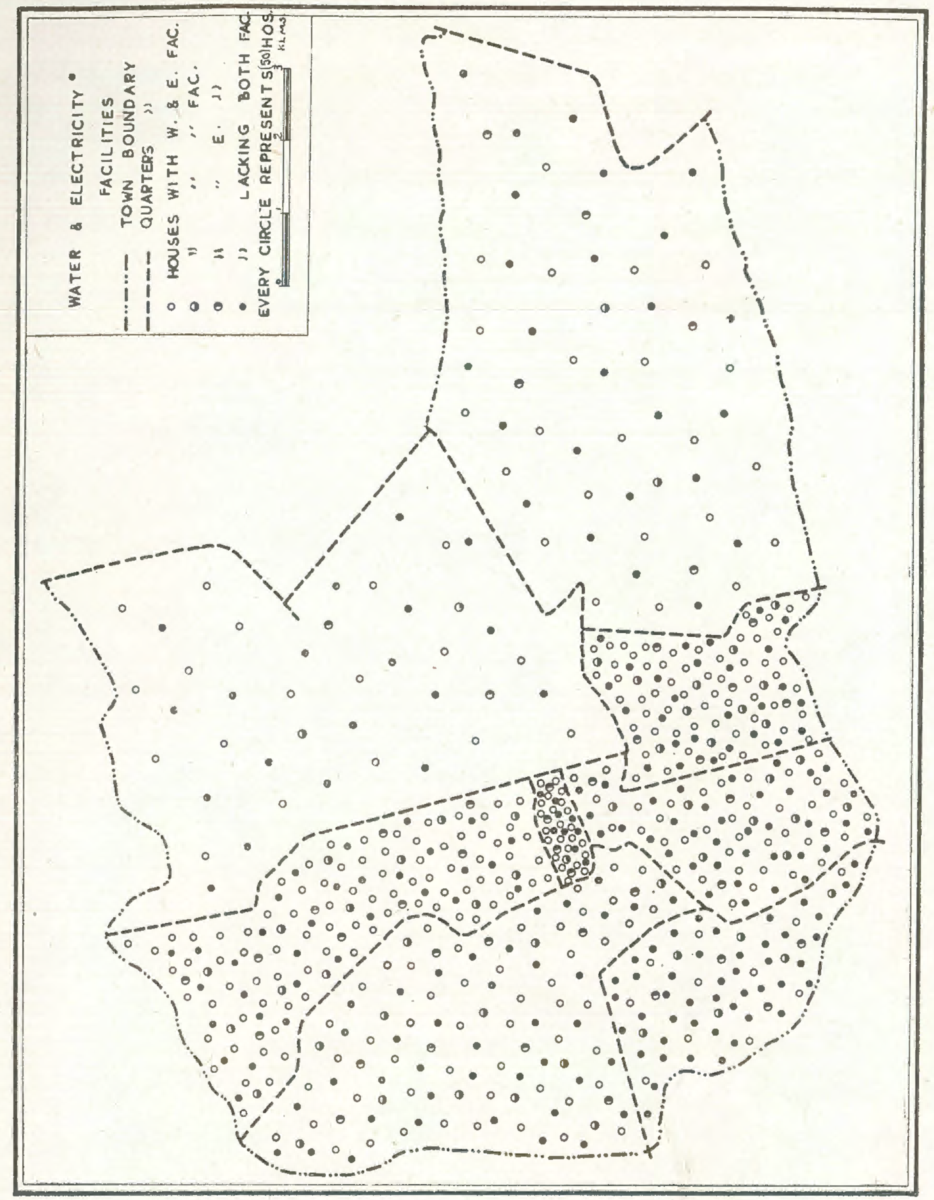
WATER & ELECTRICITY
FACILITIES
TOWN BOUNDARY
QUARTERS "
HOUSES WITH W. & E. FAC.
" " FAC.
" E. "
" LACKING BOTH FAC.
EVERY CIRCLE REPRESENTS (50) HOS.
1
2
3
KLMS

FIG. 7.

Houses connected with electricity form 7% of the total, and those supplied with water pipes are 9% of the total.

4. QUARTER THREE.

This quarter branches off the core southwestward to Wadi Hanifah, it is confined by King Faisal Street on the east, and quarter five on the north. It is characterised by its clay buildings which form 91% of the total buildings; the huts and tents at the periphery make up 5% of the total. This means that the only modern buildings which spread only in the eastern sector, if the palaces of Prince Abd Allah bin Abd El Rahman (the King's uncle) are excluded, are only 4 % of the total; some commercial shops exist among the tracts of houses especially in the eastern sector. Very few voids are seen amidst the built areas.

The working class and the native poor families of the Old Riyadh whose houses were demolished are housed in this quarter; moreover the immigrants from other parts of Najd also live in this quarter.

Only 46% of the houses are supplied with water and electricity facilities; 35 % are not connected with either water or electric plants : dwellings that enjoy only water facilities are 11% of the total, the rest are only supplied with electricity facilities.

5. QUARTER EIGHT.

This residential suburb has been recently built in the further south east of the town. It houses the settled nomads and other immigrants from many parts of Najd. Although the houses have been recently built after the year 1950, their style is neither similar to the western pattern nor to the old traditional Najdi style. They still preserve the eastern taste but are more developed than the old traditional houses. This suburb is named Manfuhah Al Jadidah (new Manfuhah).

The clay buildings form 93% of the total buildings. The rest is divided between the huts and cement dwellings. Only 16% of the houses are supplied with water and electricity, but the majority are deprived of these facilities. This shows that the newly settled Bedouins are either too poor to utilize these facilities or they have not yet developed, the taste of using them.

6. QUARTER SIX OR THE ROYAL QUARTER.

The royal quarter is located to the northwest of the town; it extends from the west bank of Bat'ha bed on the east to Wadi Hanifah on the west, and lies to the north of both the core and quarter 5. It occupies a wide area more than 1/5 of the superficial area of the town, but it includes the least number of buildings. That is because the mansions of the royal members and rich people with gardens around occupy wide areas. Moreover there are vast void areas amidst these mansions, government buildings and the other ordinary clay houses.

The scenery is very impressive and attractive as the avenues and wide roads are lined with ornamental trees with islands in the centre; there are also many public parks and gardens such as Al Murabba and Al Futa. This quarter includes many governmental building such as Kasr Al Hamraa which houses the offices and minister's council, schools, hospitals and other administrative buildings.

It is interesting to notice the contrast between the magnificent and most beautiful mansions and villas with the clay houses in their environs and the huts at their periphery. This salient feature; *i.e.* mansions lie side by side with huts and clay houses, gives a concrete example of the democracy of Islam; there are no differences among the poor and the rich, all are alike; the poor are not excluded from the royal quarter.

7. QUARTER SEVEN.

This quarter extends to the north and northeast of the town; it lies north to both the royal quarter and quarter 4; the hilly escarpments border it on the east and the west, on the north lies the airport. Two sectors make this quarter : government buildings and the residential suburb of the New Riyadh.

The different ministry buildings, military barracks and the military academy and the hospital line King Saoud street. Also, first class hotels such as Al Yammama and Sahara Palace are located in the same sector; to the extreme north lies the airport.

The residential suburb : The New Riyadh, extends to the east of the former sector. It is newly built to house government officials and their families who are transferred from Jiddah. The zoo lies to the east of the suburb, the horse race course; Municipal Hall, and the University of Al Riyadh are all Juxtaposed at the periphery of this suburb. Al Milaz street which connects this suburb with the town is a wide two way auto-strad, divided by central islands of flower beds; this road is lined with apartment buildings, schools and villas. Some commercial premises are among the houses.

The stone and cement houses form 53% of the total buildings; this percentage is the highest if compared with the other quarters of the town. Also huts and tents make the highest percentage exiting in all other quarters, they amount to 34%. The clay houses form the least percentage as they are only 13% of the total buildings. These characteristics make this quarter distinct among the other quarters of Al Riyadh.

The buildings which enjoy water and electricity facilities are 42% of the total buildings; those which do not utilize these facilities are 45% of the total. Houses connected either with water or electricity facilities are 3% and 10% successively.

POPULATION

Because of the lack of any data before the year 1963, the population of Al Riyadh was the result of guess work, either by Foreign travellers or by local authorities. The first census which has ever been taken was in the year 1962. The population was estimated at 8000 souls by Lorimer at the end of the nineteenth century; Philby's estimation in the year 1917 was 30.000. This means that the population quadrupled itself within fifty years if the former estimations were right; but the rate of the national increase especially when the high death rate is considered; never leads to such explosive results. Also, during this period the town did not receive any immigrants as its economic status was still low and Al Riyadh was suffering its maigre days. That is why the estimated figures are not reliable.

The population of Al Riyadh, according to the first official census, are 169,185 souls [1]. This collosal figure could never be explained on the basis of the natural increase of the indigenous population of the town in forty years. Certainly the natural increase presents a part of this growth because of differences between the birth rate and the death rate which has been lowered by the improving economic conditions and the resultant rise in standards of living as well as the improving medical care and hygiene existing in the Modern Riyadh. But immigration is the most potent factor that has led to this considerable increase.

Many of the nomads, encouraged by the convenient mode of life and better chances of work, have adopted the settled life in the flourishing town. Also the immigrants, from many parts of the kingdom, from other parts of Arabia and from the Islamic countries, contributed to that increase in population. The mass transference of government employees from Jiddah adds much to the increase of population. Students, in all stages of education both secular and religious, came to the town to quench their thirst for learning. Men of business have been attracted by the unlimited opportunities of founding profitable enterprises. Moreover, professional specialists are summoned by the authorities to give their services and compensate for the shortage of the Saudi experts.

The males amount to 96,368, while the females are 72,817, with a ratio of 4 to 3. The great increase of males in relation to females indicates that many of the new comers are residing without their families who are left in their homeland. This distinctive feature is concomitant to the newly grown up towns which need a lot of manpower in the sector of services. Jiddah does not differ from Al Riyadh, as the percentage of males is 57 of the total population. But the males in Al Madinah which is lagging behind the two recently developping towns, form only 52% of the total population. The size of the family inclines to be big as 59% of the families average from 3 to 8 members each; families of one or two members constitute 18% of the total population; the rest, 23% are families of more than 9 persons.

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[1] Ministry of Finance and National Economy : *op. cit.*, p. 13.

Distribution of Population.

Distribution of population in the different quarters is uneven; and three degrees of density are distinguished in the town.

First, the core is the least populated district as the displacement of residence by other functions and the demolition of old clay houses to give way for wide paved roads help to empty the core of its old inhabitants who are steadily decreasing during the two last decades. The core is peopled by 8623 or 5% of the total population of Al Riyadh.

Second, the four quarters contiguous to the core embrace 67% of the total population of the town. These quarters are the most densly populated in the town. Quarter 5, by itself contains as much people as the three outer quarters 6, 7, 8 altogether, so this quarter shows the highest densely populated district in Al Riyadh.

The population is distributed among the four contiguous quarters as follows (Fig. 8).

quarter 5	37740	persons
» 4	26045	»
» 3	27271	»
» 1	22596	»

If reasons are sought for such high density in the former quarters, one would say that the native inhabitants who moved out of the kernel chose the nearest area to their old living places; also it is more convenient to live by the market area in town where means of transport are neither well arranged nor developed. Moreover most of the immigrants, either the foreigners or the native elements of the kingdom, feel more secure in living in populous districts.

Third, the outer suburbs or quarters 6, 7, 8 are less populated and the houses are widely scattered, they embrace 22% of the total population of the town.

The distribution of population is as follows:

quarter 6	10510	persons
» 7	12443	»
» 8	14127	»

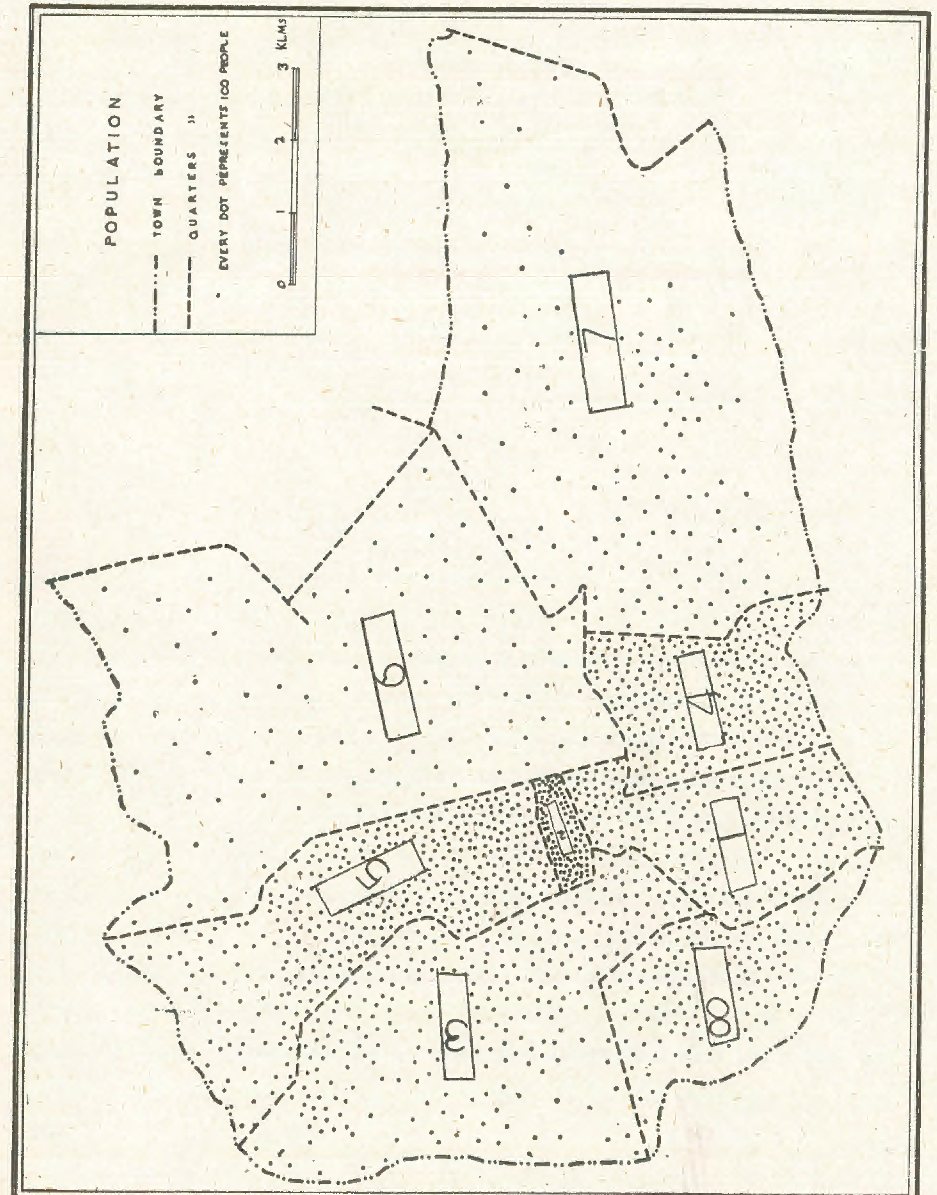

Fig. 8.

Economic Activities :

It is well known, in Al Riyadh, that females do not share work with males who monopolise activities both economic or official.

The males who carry out economic activities, excluding governmental business, amount to 34504 persons or 35% of the total number of males. They are distributed among the different economic activities as follows:

1. Commercial business	45 %
2. Industrial activities	23 %
3. Key Services	15 %
4. Building and construction	9 %
5. Agricultural production	4 %
6. Water and electric plants	3 %
7. Transport	0.5 %
8. Quarries and mines	0.5 %
	100 %

The previous table shows that commercial business has the lion's share of all other activities, it absorbs 45% of the total number working in non-governmental economic activities. The industrial occupation in manufacturing establishments rank second as they employ 23% of the total number of workers. Those who work in key services represent 15% of the total number; such percentage shows that the authorities in Al Riyadh pay much attention to develop services in order to keep pace with the growing population of the town. Workers in building and construction rank fourth; such a great number of building workers shows that the town is continually expanding and the government and people are constantly building. The number of farmers and farming labourers is very modest, such a feature is not strange in such desert surroundings, they only form 4% of the total number of workers.

Transport :

Local means of communication between the core and the outskirts are neither developed nor well arranged. It was not until the year 1964, when the local authorities began to conceive the importance of transport

services in the town, that a few buses began to transverse the capital through certain roads from north to south or from the airport to Manfuhah, others connect the Nasiriyah on the west and Al Milaz on the east with the core. Taxis, without any supervision or commitment from the local authorities, give their services to the passengers for changeable fares that rise or fall according to many factors such as supply and demand in some cases and competition in others.

Light goods as vegetables, fruits, groceries and seeds are conveyed by carts from the wholesale market to the retailers; heavier goods such as furniture or the like are carried by lorries. Porters play an important part in carrying goods from place to place either on their heads or on their backs.

Supply and home trade :

The agricultural hinterland of Al Riyadh embraces the oases of Wadi Hanifah and the nearby districts; the districts of Al Kharj. (84 klms. from the town), Manfuhah (4 klms.), Al Dir'iyah (15 klms.), Al Jubailah and Al Uyaynah (40 klms.), and Dhurma (85 klms.) are the main agricultural terrain that supply Al Riyadh with vegetables such as : Tomatoes, eggplant, potatoes, peas, beans, broad beens, cabbages, cauliflower, turnips, radish, carrots, spinach, okra, etc. Fruits such as watermelons, banana, citrus, pears, peach, apricot, figs, sweetmelon, grapes and dates are also cultivated in the hinterland. The agricultural districts of Al Qassim (500 klms.) such as Bureidah, Al Rass, Onaiza and Al Asiah which grow the previous kind of vegetables and fruits help to cover the local consumption of these kinds in Al Riyadh. Moreover many kinds of fruits and vegetables such as apples, grapes, oranges and potatoes are imported from Lebanon, Syria and Jordan by means of lorries via tapline road. Imported canned vegetables and fruits help to cover the local needs.

Wheat, Sorghum, millet and beans are so scantily grown, in the former districts, that they only suffice a very little portion of the local consumption which depends largely on imported articles from other Arab countries and the United States of America.

Livestock are reared every where in the hinterland of Al Riyadh and so dairies are to be seen everywhere in the environs, but their products never meet the local increasing demand for them. Thus livestock imported alive from Somalia and the neighbouring countries, butter and both condensed and evaporated milk from Denmark, cheese and eggs from the Netherlands, iced chickens and canned meat from western European countries, form the bulk of the local consumption.

Thus, if the former local products are excluded, the local consumption depends on imported goods from different countries. It is hard to sort out every imported article and the importing countries in such a little space, so only some examples will be mentioned. Rice and tea are imported from India and Ceylon; coffee from Al Yaman, Ethiopia and Somalia; spices from Malaya and Indonesia; olives and olive oil from Lebanon and Syria; sugar from Egypt, India and Aden; cloth from U. S. A., England, Japan and India; industrial machines, electric equipment, motor cars and manufactured articles from U. S. A., England, Italy and Japan; medical equipment from England, West Germany, Japan and Czechoslovakia. In a word, the local consumption and home trade depend on the imports which are easily paid for from the oil revenues.

The formerly stated items of nutrition show clearly that the people of Al Riyadh have changed their dietary habits. From a diet that used dates as the basic staple and rice as the most important supplement, the people have shifted to rice with meat as the basic food item, supplemented with a large variety of foodstuffs, mostly canned or packaged and commonly imported. Eating foreign things has become a fashionable fad in the town, as the people are encouraged by the spreading effects of the high cash wages and the prosperity resulted from oil industry.

The Process of Change : Physical and Social.

Al Riyadh, as an oasis village in the heart of Najd, was isolated and cut off from the outer world. The camel as the only means of transport did not help much in connecting the desert village with the ports on the Red Sea and the Arab Gulf; moreover this tiresome and rugged wilderness

did not encourage the foreigners to pass or contact it. Also the people who were stiff and unpolished as an outcome of the cruel desert environment, felt hatred to the foreigners who might come to them. Even in the first decades of the nineteenth century, no one visited al Riyadh except with the King's permission and all who did so were the King's guests. Thus, the people did not come under any foreign sphere of influence.

Naturally the inhabitants of Al Riyadh were strictly dominated by old traditions and religious sanctions; moreover, the limited economic conditions under which they live, did not allow any significant change in the inherited patterns of life. The resultant pattern of life existed in the town before the recent modernisation was as follows :

The house was one or two storied building of mud bricks; the plan of the house is built around religious principles, or in other words, the status of women is the pivot around which the plan of the house revolves. The main feature is the courtyard around which the rooms are built; the windows facing on this courtyard or the lane are higher than the average so that no one could see in; the low walls on the roof, the complete segregation between men's sitting rooms (Al Majlis) and women's living rooms; all these arrangements and precautions are meant to keep the women in privacy and out of men's sight. The open courtyard inside the house includes all the necessities as the privy, the kitchen, the well, the oven and lastly a stable for domestic animals, if the owner has not a stable annexed to his courtyard. The rooms are spacious, the plastered walls and doors are decorated in gaudy of colours; the ceilings which are covered in the houses of the well-to-do, with cotton cloth, contain highly embellished designs. The fireplace for making coffee in the reception room is a principal feature in the old houses of Al Riyadh.

Recently, many of the inhabitants left these old clay houses and are living now in new modern houses with sanitation facilities. Their new economic status helped them to lead a comfortable life in the new modern dwellings.

Women were rarely seen, and if they were seen at all in the market or the lanes of the old village they were covered from head to foot, but

now women from different countries wander freely in the markets and streets unveiled. Their short skirts and nylon stockings or bare legs and neat high heeled shoes were never seen before the last decade in Al Riyadh. Women of indigenous origin are still veiled, but their garments have become more revealing than those of their sisters in the old village, moreover they are more freely seen in the streets and markets than before.

The men, in the old village, would appear in public in Arab dress; and that applied both to the indigenous elements and the Muslim foreigners; but now European dress is frequently seen. Teachers, technical experts and other foreign elements wear European dress; also some of the native elements, the troops, officers, and policemen all wear European uniforms.

Such a change has been the result of the contact with foreign elements, and also the powerful influence of school teachers on the younger generation is responsible for that change.

Smoking and photographing were strictly forbidden by the religious zealots and were never allowed in public; but now somkers are seen everywhere and cigarettes are sold in public, photographers occupy shops in the most important streets. Actually, it is a revolutionarily change to have such novelties in Al Riyadh.

Magnificient motor cars take the place of the camel and the donkey too; modern cafées, luxurious hotels and restaurants, and other urban features have seen the light through only the last decade.

In a word, after the people of Al Riyadh have mixed with the immigrants from other Islamic and western countries, the tempo of the process of change has been quickened in a way that the transformation scene in the Modern Riyadh would transcend the dreams of those who saw and knew the old village of the same name. The physical and social revolution which has been the result of the oil royalties and the concomitant flow of imports and new comers, helps to develop Al Riyadh into one of the best towns in the Middle East.

A RECENT KARSTIC PHENOMENON
IN THE LIMESTONE COUNTRY
OF NORTH CENTRAL NEJD, SAUDI ARABIA

BY

Y. ABUL-HAGGAG

Late in 1962, under the heading « *A Manifestation of Allah's Might*», a local newspaper in Riyadh announced that a « huge» land-subsidence (*khasf*) occurred suddenly near the village of Midhnab (Al-Midhnab) in the Qassim Province. Preachers in Saudi Arabian mosques were urged by the Qassim religious body to use this event as a reminder of God's might.

In view of the presence of similar features in Nejd (e. g. the Kharj pits and the Aflaj pits), the news seemed to be of a special morphological interest. I asked the Riyadh University—where I was then teaching—permission to visit the area to record and attempt to interpret the phenomenon. The permission was kindly given and I arrived at Midhnab on March 28th, 1963.

Measurements were made with a steel tape and the clinometer of a Brunton Compass.

DESCRIPTION OF PHENOMENON

The new cavity lies 3 kilometres south-west of the village of Midhnab, some 35 kilometres south of Uneiza (Fig. 1). At the entrance it is an almost perfectly circular, vertical-walled depression, 6.5 meters in surface diameter. Like the much larger and deeper Ain El-Hit cavity, which lies some 30 kilometres south-east of Riyadh, it is not a vertical hollow, but was formed along an inclined plane, the cavity sloping here

downwards from the surface in a northerly direction at an angle of 40°. The floor is covered up with dry fragmented rock fallen from above and accumulated in an irregular manner. The depth is therefore variable, being 3.6 meters at the entrance open pit and less in the remaining cavern-like part.

The horizontal extension, i. e. the distance between the mouth of the cavity and its northern extremity is some 10 meters. The lowest part is 7 meters below the surface [1] (Fig. 2).

The cavity was formed in the Khuff Formation, a limestone of Permian, probably upper Permian, age. In a type section near Ain El-Khuff, about 110 kilometres to the south-west, this formation was described as a chalky, dense limestone, 235 meters thick, resting unconformably on the Saq Sandstone (Cambrian?), though elsewhere in Saudi Arabia it rests on other lower Palaeozoic units or on the basement [2]. In the cavity area the formation is a grayish white, chalky, thinly bedded, well jointed limestone, with pockets of gypsum and thin bands of shale.

The lithology of the cavity walls, which, as just mentioned, is 7 meters in section, conforms well with this general description. Save for six thin intercalated bands of shale, varying in thickness from 2 to 10 centimetres, and sporadical tiny pockets of gypsum, the rock is throughout a marly, chalky, thinly bedded limestone. It is a moderately soft rock; with little effort it can be broken by hand. Jointing, both horizontal and vertical, is well developed. In the lowermost meter of the section the limestone is covered with a thin film of carbonic material that stains the hand.

Structurally the Midhnab area, like the remaining parts of the Nejdian plateau, is almost flat, with a dip of only 2°-3° to the east [3]. Yet, with

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[1] This was estimated by lowering the tape from the northern rim of the entrance pit to the debris-covered floor below and then levelling down in the cavity to its lowest extremity.

[2] Max STEINKE, R.A. BRAMKAMPF, and N.J. SANDER, *Stratigraphic Relations of Arabian Jurassic Oil,* Habitat of Oil. The American Association of Petroleum Geologists, June 1958, pp. 1301-1302.

[3] For more information on the structure and geology of the country, see the author's article «On the Artesian Water of Nejd, Saudi Arabia» in the present issue of the *Bulletin.*

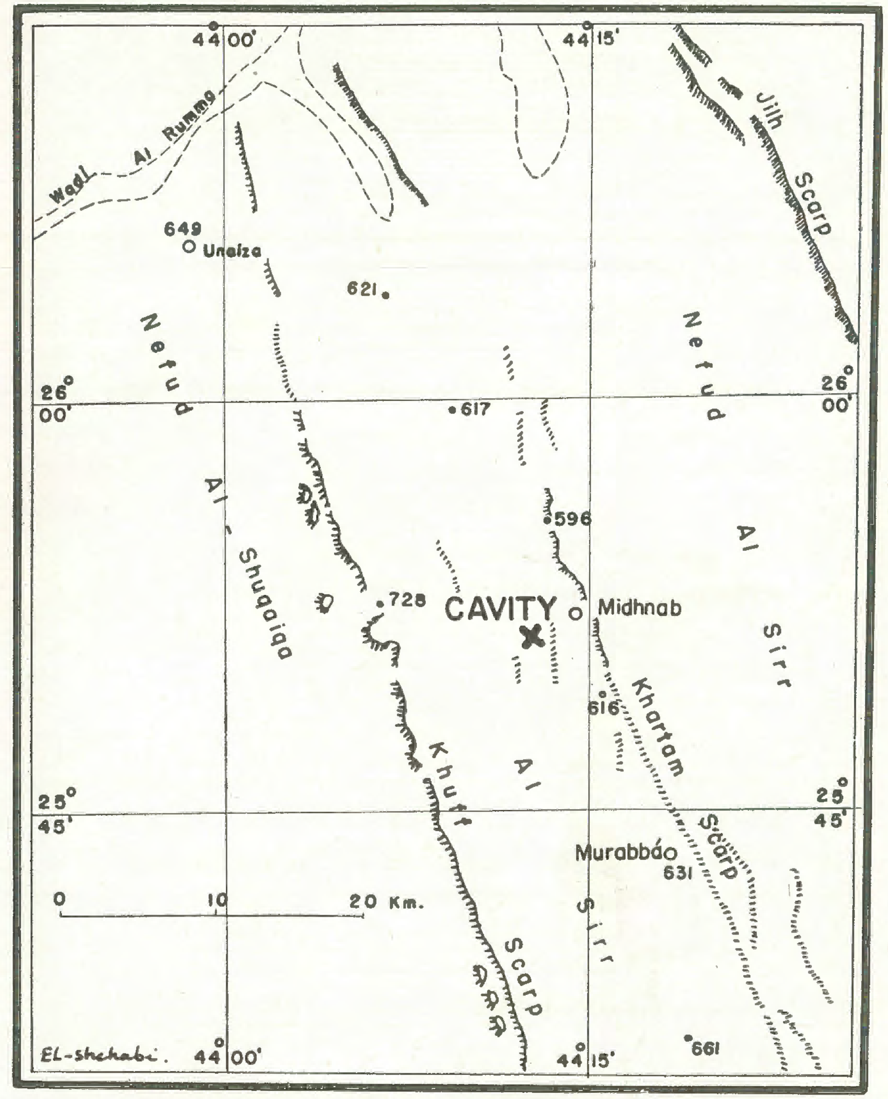


Fig. 1. — Location of the recent solution cavity and main topographic features in southern Qassim.

the almost complete absence of a vegetative cover the land has been eroded into a fine scarpland topography which assumes all the essentials of cuesta-landscape. Cuesta scarps as e. g. the Khartam and Khuff scarps, respectively east and west of the Midhnab area (Plate I, *a-b*), dip-slopes, and subsequent strike lowlands occupied by subsequent *wadis,* as e. g. the fertile cultivated Sefala plain east of Midhnab, are persistent elements of the landscape, developed with a remarkable sharpness of detail.

It is in a small such subsequent plain, some 600 meters above sea-level, that the recent cavity was formed. A few meters to the east rises a west-facing, rectilinear scarplet carved out of a fairly hard limestone bed of the Khuff Formation and attaining an elevation of less than 2 meters (Plate II, *a-b*). The cavity is also situated in a small shallow depression descending only about 50 centimetres below the surrounding surface of the plain and constituting the head of a little subsequent *wadi* that runs southward. A veneer of silt, 15 centimetres thick, covers the mother rock. About 300 meters to the west begins the very rocky surface (*safra*) of the same dip slope, extending up to the edge of the Khuff scarp.

INTERPRETATION

The Midhnab cavity is obviously a solution cavity brought about by the solvent action of underground water in limestone and the subsequent collapse, complete or partial, of the roof. The well-developed system of intersecting joints and the presence of gypsum, a more soluble rock than even limestone must be given due weight as causative factors. The local distribution of the joints and gypsum pockets should also explain the variable intensity of the collapse, there being no sign of any structural disturbance in the area.

The foundering of the roof must have been sudden and violent, since the fallen fragments in the bottom of the cavity are well broken up. The sudden occurrence of the event was also confirmed by the local inhabitants. The surrounding shallow depression may, however, indicate a precursory subsidence in the surface due to a progressive, partial

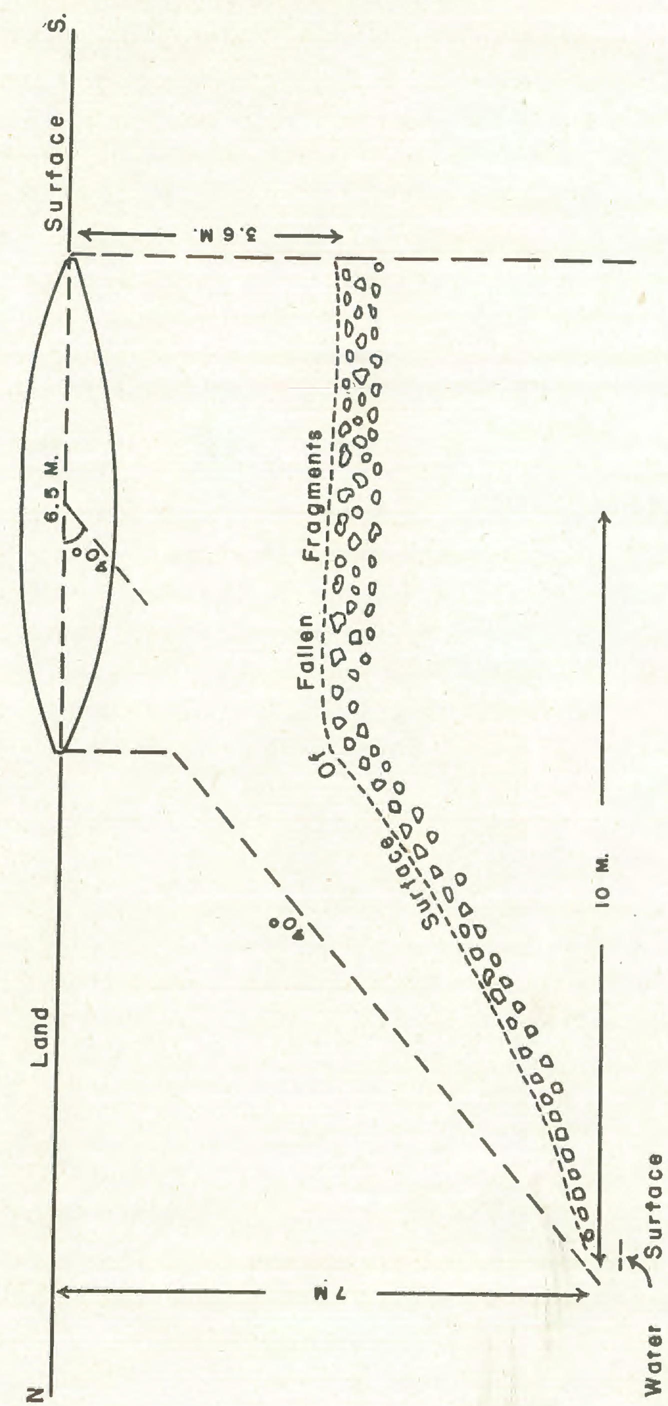


Fig. 2. — Dimensions of the Midhnab solution cavity.

removal of its underground support. Lack of time prevented a three-points dip measurement on the surface of the depression. Considering the slight thickness of the silt cover, i. e. the nearness of the mother-rock to the surface, the true structure of the depression can perhaps be easily determined, and its origin clarified.

At the time of my visit water (slightly brackish) was noticed only in the lowermost part of the bottom (i. e. in the northern extremity of the cavity), its surface lying some 50 centimetres under the blackened debris surface, that is, about 7.5 meters below the land-surface. I could not, however, ascertain whether this was underground or rain-water. Only three weeks before my visit, the Midhnab area had witnessed a violent shower, traces of which were still in evidence. A short distance south of the village a large, fresh-water lake, nearly 4 kilometres long, still occupied part of the subsequent plain extending below the Khartam scarp and locally known as the Massya basin. The mud-houses of Midhnab were severely hit and many inhabitants were still living in tents dispatched from Riyadh. The surface of the water in the cavity is near enough to the local water-table in the area, but it is also possible that it represents rain water that had infiltrated through the debris. I later asked the headmaster of the Midhnab Saudiya school to re-visit the place and investigate. A letter from him, dated July 16th, 1963, informs me that after lowering a small stick in the spot, he found no water.

Another uncertainty is whether there is any relation between the occurrence of the cavity and the recent extensive use of underground water by the Midhnab farmers. The local water table, from which the traditional wells produce, lies at a depth of about 10 meters. But in 1958 artesian, free-flowing water, discharged under strong hydraulic pressure, was discovered in Midhnab, and 8 artesian wells were producing in 1963. Did this lead to a faster movement of the underground water in the water-table zone, thus helping to bring about the collapse? The main source of the artesian water in the area, it is true, is a deep horizon, some 560 meters below the surface. But the wells are not appropriately cased, if any casing is used at all, and water from the upper producing zones would thus seep through the walls of the wells. Such seepage has often been reported in the Buraida area further north.

It should, however, be noted that many old other solution features occur in the Midhnab area. About one kilometre north of the recent cavity, in the same Khuff limestone, is the ʿAin El-ʿAḳeeli natural pit. Another kilometre further north is the ʿAin El-Garia pit. South of the recent cavity is the alluviated Nabʿaa (= spring) basin, while, unlike the ʿAin El-ʿAḳeeli and ʿAin El-Garia pits, no more possesses a pond.

For comparison with the recent cavity, I made a short study of the ʿAin El-ʿAḳeeli pit. It is a semi-circular, steep-walled, open pit, about 8 meters in diameter and 6 meters deep. It contains a small shallow pond of slightly brackish water, but according to the local inhabitants, only a few years ago this pond was much larger and deeper, its level reaching up to some 2 meters below the rim. Some of this water was then conducted through a canal to Midhnab for irrigation purposes. With a general fall in the water-table the pond shrank and the canal ceased to function.

There seems to be no doubt that the ʿAin El-ʿAḳeeli pit is also a solution cavity, which is, however, completely deroofed and perhaps subsequently enlarged. Its present basin form would probably be the destiny of the recent cavity. In time, this latter will also be completely unroofed by the infalling of the ceiling which would be effected mainly by rain-water, percolating from the surface or entering the cavity through the entrance pit, and by weathering. The present inclined cavity would thus develop into a completely open pit which would also be enlarged by the recession of its walls under weathering and erosion. The fallen fragments would be comminuted by chemical and mechanical weathering and would be in part carried away by wind-sifting. If the water-table does not continue to fall a pond should soon come into existence.

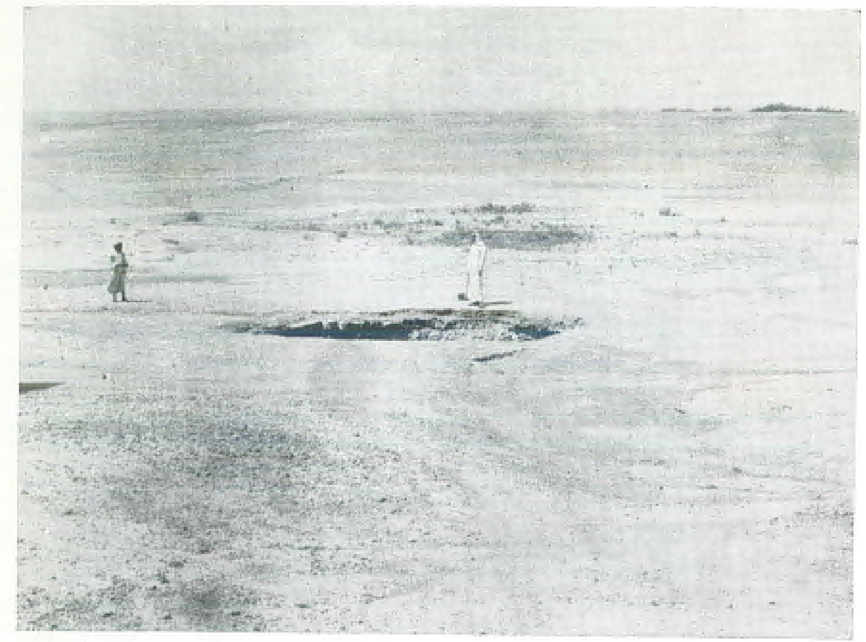
CONCLUSION

The Midhnab recent *Khasf* is a Karstic phenomenon, a solution cavern-like cavity formed by the solvent action of subterranean water in a well-jointed, gypsiferous, moderately soft limestone and the subsequent collapse of the roof. Its mode of occurrence and its possible later evolution, as suggested above, should throw light on the origin of the many

comparable features in the Nejdian plateau, as e. g. the famous Kharj pits, the *Khafs* Daghra and the Aflaj pits. Tectonic factors are not involved. Nor is it any more necessary to attribute such phenomena to the Pluvial Period.

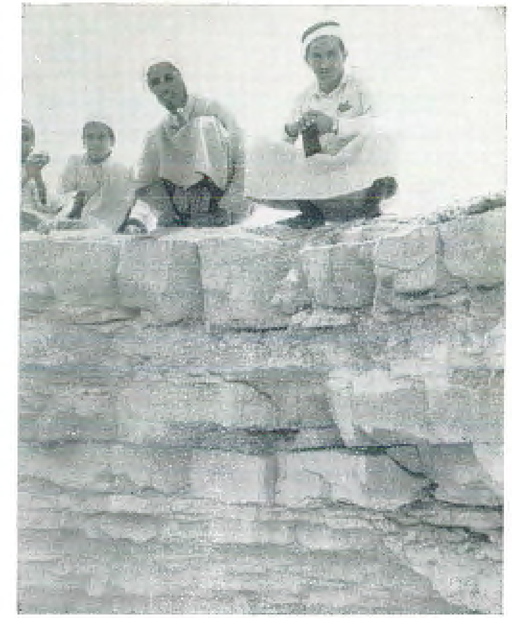
ACKNOWLEDGMENT

My thanks are due to the Rector of the Riyadh University, to Mr. Mohamed Al-Rasheed, headmaster of the Saudiya Midhnab school, and to Sheikh ʿAbdalla El-Ḳiʿaan, governor of the Midhnab District, for the many practical facilities they generously provided.



A. — The Midhnab solution cavity, and a general view of the subsequent plain in which it was formed.

B. — A closer view of the cavity looking north along the inclined plane of the cavity. The dark area inside is part of the inclined ceiling.



A. — The Khuff limestone as seen in the wall of the entrance pit. Note the joints, the regular bedding and the veneer of silt.

B. — View looking east. Note the N.-S. trending scarplet, carved out of a harder member of the Khuff formation.

GEOGRAPHICAL OBSERVATIONS
IN
WESTERN ARABIA

BY

Y. ABUL-HAGGAG

The subject-matter in this article is based mainly on two trips made to Western Saudi Arabia, one in the spring of 1962, the other in the winter of 1963. Both trips were financed by the Department of Geography of the Riyadh University.

In the first trip I flew from Riyadh, over the west-central plateau of Nejd and the northern extremity of the Rahaṭ *harra*, to the sacred town of Medina (Al-Madina Al-Munawara). From Medina a number of side trips were made : to Mt. Uhud (Jabal Uḥud), the Aqul volcanic area and the Uyun palm gardens in the north-east, and to the Abyar Ali area in the south-west. Following the Medina-Jedda road across the igneous backbone of Western Arabia to the small town of Badr (150 kms. from Medina) I took the road branching along the coastal plain to the small part of Yanbu Al-Bahr (*i.e.* Yanbu of the Sea), about a 100 kms. further to the north-west. From that port a trip was made to Yanbu Al-Nakhl (*i.e.* Yanbu of the palm trees) along a motorable but bad track (45 kms.). The journey from Yanbu to Jedda (400 kms.) along the asphalted road, via Badr, provided opportunity for inspecting the coastal lowlands, some features of the Red Sea coast and two of the western tongues of the Rahaṭ *harra*. A visit was then paid to Mecca along a good asphalted road (75 kms.) with small side-trips on the way.

A flight from Jedda over the Taīf (Al-Ta'īf) plateau, the southern Rukba plain, the Buqum *harra* and the Asir mountainland (via Taīf, Turaba and Bisha) brought us to the Khamīs Mushait aerodrome east of Abha.

From this aerodrome we drove to Abha along an ill-maintained road (40 kms.), to the south of the old Turtish road.

From Abha four trips were made in different directions, with the intention of covering as much variety of landscape as possible in this interesting and colourful country : northwards to the Sha'ar area and the sources of Wadi Tayya via Bani Rizam and Faya and back to Abha via Suda (Sawdah) on the crest of the Asir escarpment; south-eastwards to El-Qara'a via Al-Yazid; in the same direction, on another day, to Suq Al-Ethnain further to the south, then up to the Tamniya plateau; and eastwards to Khamīs Mushait.

The journey back to Hejaz was an interesting flight from Khamīs Mushait over the imposing Asir escarpment and the Tihama highlands to Jizan, thence over the shores of the Red Sea and the coastal lawlands to Jedda.

The second trip was limited to Hejaz. Most of the places visited in the First trip were then re-visited, with the addition of a trip to the Zayma oasis in wadi El-Yamaniya, north-east of Mecca, another to beyond Sheddad on the new Mecca-Taïf road, and a third to the small Sa'ad island near Jedda.

A DIVERSITY OF LANDSCAPES

Contrasted with the interior Nejdian plateau or the Arabian (Persian) Gulf coastal plain, Western Saudi Arabia should constitute a major geographical unit of particular characteristics. Yet this should amount to no more than a mere generalisation, and is perhaps misleading if any realistically vivid picture of the landscape is envisaged.

Diversity of geographical landscapes in this region is in fact the most striking picture presented to the investigator. The Red Sea coastal lowlands (Tihama) with its late Tertiary and Quaternary formations, a subdued topography, a desolate appearance, a hot and damp climate, and a very sparse population leading-outside Jedda-a very simple life, are in sharp contrast with the adjacent highlands with their crystalline rocks and lava fields, variegated scenery, strong relief and high altitude attaining in places more than 2500 metres above sea level, milder climate, relatively large oases and a predominantly settled population with a glorious history in trade and religion.

Yet contrasting conditions within each of these two major provinces admit of a further division. The northern coastal lowlands should, at least from a human geographical standpoint, constitute a unit that is sufficiently distinct from the southern Tihama. The differences being mainly a function of location, the northern sub-region, exemplified by the Yanbu area, reveals more truly Middle-Eastern characteristics, manifest in the physical traits of the inhabitants, in their forms of settlement and in their social structure; while in southern Tihama, exemplified by the Jizan area, a definite African air is superimposed in all these respects.

The distinction is even more emphasized in the highlands province between its two sub-regions, namely, Hejaz in the north and Asir in the south, roughly north and south of the Mecca latitude. Hejaz is an arid mountainland of igneous and eruptive rocks, with scattered small and large oases, even though for reasons of location and religion urban life has always been a prominent feature. Water resources are rather poor and the elaborate system of *Kehriz* (here called *dabl*) irrigation is still in use, though the donkey-drawn «saquias» have almost disappeared. Vegetation is scarce but the palm tree is quite at home. A country of large scale pilgrimage, its conservative population is manifestly cosmopolitan with representatives of almost every corner of the Islamic World.

Asir is almost another world. Higher in altitude and nearer to the monsoon domain, this highland of igneous rocks has a larger share of rainfall and the presence of mist is reminiscent of conditions in its counterpart on the other side of the Red Sea, namely the Eritrean plateau. Agricultural activity is well established, with skilfully terraced fields as a marked feature. Ground-water remains a cherished supply but no *debul* are to be seen and the donkey-drawn «saquias» are widespread. Vegetation is quite richer than in Hejaz, and in places veritable forests of the evergreen juniper trees ('ar'ar) with a complete disappearance of palm-trees, lend a humid temperate luxuriance to the landscape. A remote country of limited resources, its population has been able to

retain a number of both physical and social distinctive traits. A fair complexion and even blue eyes are quite common in many localities. Freedom of the Asiri woman-to mention only one social characteristic-is something of which the women-folk of Mecca and even Jedda cannot dream; she goes about unveiled, wearing a broad-brimmed hat and a European-styled overcoat, and she receives and entertains guests at home.

GEOMORPHOLOGY

The Igneous Backbone

Concentrating now on the contrasts exhibited in the morphological landscape, the highlands province, the igneous backbone of W. Arabia, naturally attracts the main attention.

Extending continuously throughout Hejaz and Asir in a generally N.W.-S.E. direction, more precisely parallel to the Red Sea coast, this province represents the greater part of the eastern rim of the Red Sea graben. Like its equivalent on the African side it is a wild mountainland of great height and majestic appearance. Following the pilgrims' route from Jedda to Mecca one is all the way struck by the sight of bare, steep-sided and jagged metamorphic mountains of varying colours and outlines, utterly wild and awe-inspiring. The road between Medina and the coastal lowlands affords an even more imposing landscape. The traveller is encountered here and there by level intermontane basins with a relatively rich vegetative cover of short acacias and thorny bushes (Pl. I, A), but the grim mountains are always in sight and the famous great Uhud massif seen at the outset of the journey near Medina proves to be only one example of a multitude of spectacular mountains (Pl. I, B). Level summits exist and, in schistose terrain, a semblance of horizontal bedding may be noted, but these represent a rare scene. Contortion of the rocks and lack of symmetric structures is the order of the day. The occasional occurrence of steeply tilted hogbacks, as *e.g.* between Abyar Ali and Museijīd (Pl. II, A) is only a departure from the general rule, conveying, as it should, a feeling of relief, in an otherwise almost chaotic landscape.

The road between Mecca and Taīf via the small oasis of Zayma affords opportunity for inspecting the variety of landforms carved out of granite and granitoid rocks, although metamorphic rocks are also present in close juxtaposition. It is in the Asir plateau, however, that the most extensive outcrops of granite are to be seen. Whether in Turaba, Bisha, Khamīs Mushait, or south of Abha on the road to Najran granitic landforms are always lavishly displayed. Elsewhere in Asir metamorphic rocks prevail, but the land surface remains generally well dissected and of strong relief, while Asir can also boast of its great escarpment overlooking the Red Sea graben.

Effects of lithological variations :

With this bird's eye view in mind, we may now proceed to an analytic study of the morphological landscape of the igneous backbone. The constituent rocks belong mainly to the crystalline basement of Arachaean or Pre-Permain age. Volcanic rocks of a later age outcrop in places forming more or less extensive lava fields, but these *harras* deserve separate treatment. In the Liḥaf area, south-east of Abha, the basement is covered with a small outcrop of a resistant, reddish-brown, crossbedded sandstone of Nubian type, the so-called Wajid Sandstone (Permian or older). Wherever this sandstone forms the hill-summits, as *e.g.* in the Tamaniya plateau, it is morphologically reflected in a generally level mesa-like disposition of these summits, a rare feature in the landscape (fig. 2).

Everywhereelse the land surface consists of the usual metamorphic and intrusive rocks of the ancient igneous complex. Like analogous formations on the other side of the Red Sea this series is possessed of an extraordinary variety of lithological constitution. A particular class of rocks may prevail in places, as do granites in extensive areas in the interior of the Asir plateau, and metamorphics, particularly schists, in the country east of Jedda and in the Tihama mountains. But the general rule is almost everywhere a rapid lithological change and an intimate intermixture of varying rocks. Variations occur in the same rock, while innumerable dykes and sills and veins that can often be easily noticed in many localities add a further complication.

On account of this heterogeneity of rock composition, the morphological landscape is extremely diversified. This is true even in the western part of the Asir plateau, a comparatively easy belt of country along which extends the road from Taïf to Najran. Almost everywhere erosion, particularly river erosion, has dismembered the original surface into a multitude of mountains of varying forms and valleys and relatively small plains also of different forms, while in the western slopes of the Asir plateau the scene assumes an almost Alpine character.

Some order in this seemingly chaotic landscape may, however, be gained from a distinction between the landforms sculptured in granitic terrains and those of metamorphic country.

Owing to its intrinsic qualities granite everywhere gives a characteristic landscape, so that the effects of climate variations are generally attenuated. Whether in Asir or in Hejaz its presence is often heralded by the blocks of varying size in which it is usually broken (Pl. II, B and Pl. III, A). The outline of these blocks is determined in the first place by the prevalent mode of jointing. Jointing, always a feature in granits, may be of the mural or curved type, and the blocks may therefore be of a cuboidal or rounded outline. Other forms also exist, for jointing does not always follow a systematic pattern, while sills and veins also intervene in this respect. The rounded form tends, however, to be more widespread than the other forms in the Asir plateau. Exfoliation and the usual fissuring of the blocks are well developed. In many instances these blocks are piled one above the other in precariously delicate positions, as can often be seen along the road between Abha and Suq Al-Ethnein. Granitic massifs may have smoothly rounded summits, as, *e.g.,* Jabal Al-Nur near Mecca (Pl. III, B). Not less frequently they may be eroded into steep angular forms, with serrate crests, soaring pinnacles and ragged spurs and ridges. Granitic mountains are very steep-sided and in many place almost unscalable.

Drainage in granitic terrain is usually of a fine texture and dendritic pattern, features that can be observed, for instance, in the upper Bisha basin in southern Asir. That granite can sometimes be of a modest resistance is attested by the occasional development in predominantly granitic terrain of intermontane basins and wide valley tracts. Numerous such

plains, dotted with granite knobs and hillocks occur in the country extending south east of Abha and in the Khamīs Mushait area, while, in Ḥejaz, Wadi Al-Yamaniya (Upper Wadi Fatma) has in many places managed to excavate a wide valley in granitic country. In Zayma, Wadi Al-Yamaniya is also so level-bottomed and its gradient so low that a fine alluvial fan could be formed by one of its small affluents (fig. 1).

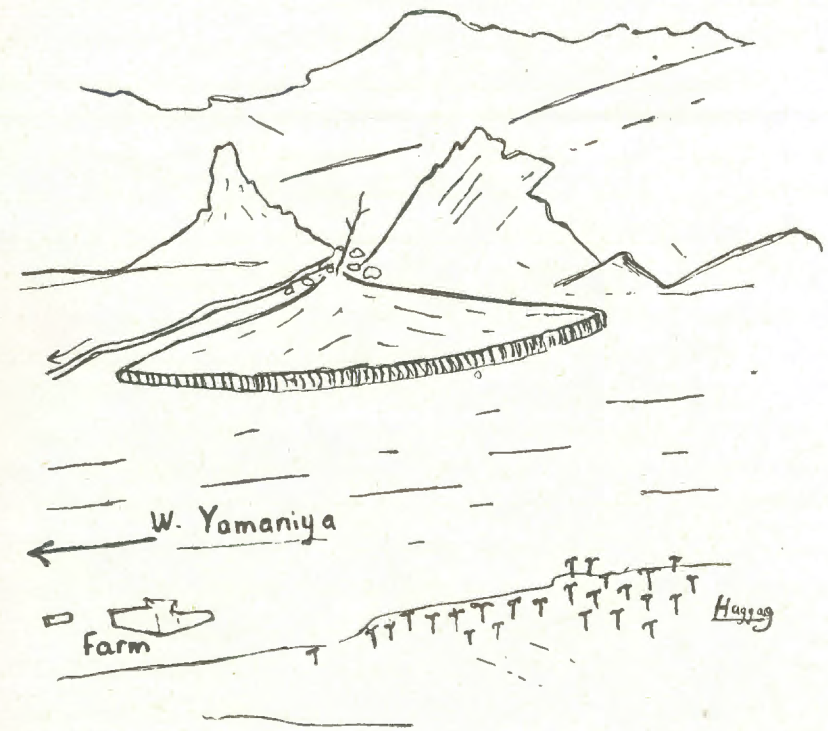


Fig. 1. An alluvial fan formed by an affluent of Wadi Yamaniya (Up. Wadi Fatma) in Zayma oasis. Note steep face of fan, trimmed by the main wadi.

In metamorphic terrain, on the other hand, the landscape is generally less rugged. The hills tend to assume rounded and smooth outlines, while their slopes are in places covered with moderately coarse debris, instead of being boulder-clad like granitic mountains (Pl. IV, A). Jabal Al-Raḥma in Arafat-just to mention a religiously famous example-has a smoothly rounded surface and is easily climbed by Moslem pilgrims every year.

Yet metamorphic rocks are extremely variable in resistance and the resultant landforms can sometimes approach the craggy and bizarre outlines of granitic landscape. Drainage also reveals variable characteristics. Where the soft argillaceous schists prevail the land-surface has been profoundly dissected by river erosion, and the valley floors are often disproportionately wide, with innumerable earthy mounds giving the whole scenery a chaotic and wild appearance.

Homoclinal ridges constitute a persistent feature in schistose terrains where stratification is pronounced and the strata are of variable resistance. Long successions of such ridges are particularly prominent in the Asir plateau (Pl. IV, B). They are also encountered in many localities in Hejaz, as, *e.g.*, along the Jedda-Mecca road. The strike of foliation coincides with that of stratification and a steep inclination, attaining 45°, is normal. Much steeper inclinations, approaching verticality in many places, also occur in schists (Pl. IV, A), details which are reflected in the moulding of landforms.

It is, however, to be noted that, independently of lithological constitution hill outlines in the Asir plateau are generally more subdued than in Hejaz. Relief remains strong, but angularity of topography is much attenuated, curved slopes being more of a feature. This difference should be related to the varying climatic conditions. Unlike the arid north, the Asir plateau receives an annual rainfall attaining in Abha 300 mm. and is possessed of a substantial vegetative cover in many localities. The solvent chemical action of water is therefore more effective and the binding effect of plant roots is far more pronounced than in the bare mountains of Hejaz. Hence the marked tendency towards convexity of slopes, though the feature is not so well developed as it is in humid temperate regions of normal erosion (Pl. VI, A and fig. 2).

Lava flows give a different morphological landscape. As in Yemen and in Ethiopia, these *harras,* especially extensive in Hejaz, consist mainly of basaltic sheets dotted with extinct small volcanoes. Inspite of the general flatness of the land-surface in these *harras* they form notoriously rough stony terrains which have been avoided by both caravan routes and modern roads. The overlying monts assume different shapes. An interesting form of scenic beauty that shows well from the air in many

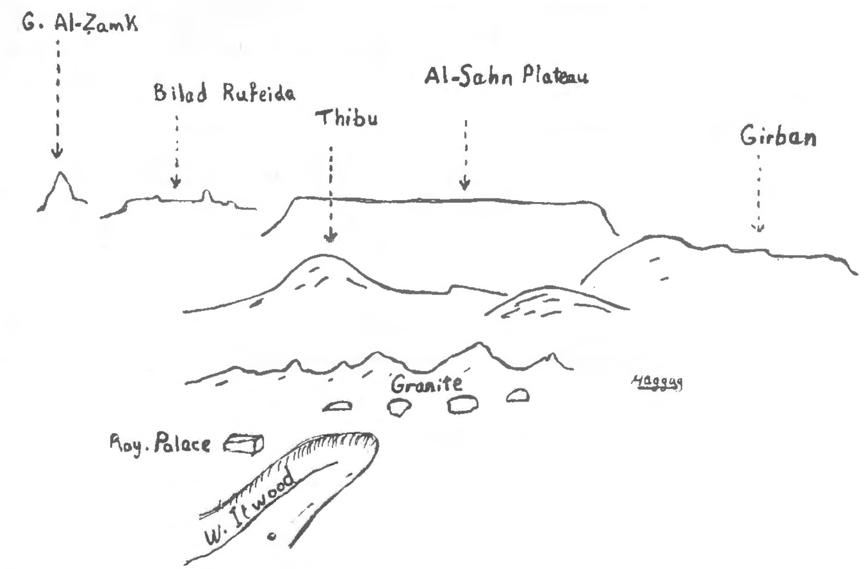


Fig. 2. Panorama drawn from escarpment-crest near Qara'a, south east of Abha, looking towards the interior. Note the flat-topped Sahn plateau (sandstone); the rounded summit of the Thibu (metamorphic); the granite blocks and hills (foreground).

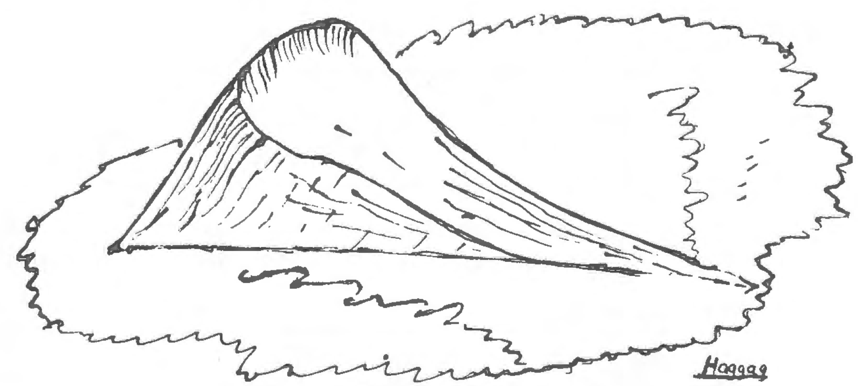


Fig. 3. An asymmetric cirque-shaped lava cone in Harraṭ Kishb as seen from the air. Note the lava flow spreading all round the cone, i. e. not restricted to ground facing scoured side.

localities is shown in fig. 3. The cones have here been scoured out in one side by river erosion, probably because of the original asymmetry of the cone-outline and the resultant concentration of erosion on that side.

Two surfaces, representing two main phases of eruption are morphologically recognizable in these *harras*. The older surface, of a reddish gray tinge, is more eroded than the newer (dark gray), as seen, for example, in the southern part of Harraṭ Rahaṭ. Dissection is, however, still at an early stage in both surfaces, and in some of the newer lava sheets the surface is very well preserved. In the Aqul area near Medina the surface is in fact almost intact (Pl. V, A).

In places the lava has occupied river valleys, as witnessed by the tortuous narrow courses of the lava tongues that branch from the western borders of Harraṭ Rahaṭ across the coastal plain. North of Khulays village (75 kms. N.N.E. of Jedda) a tongue of this type now forms a low, tortuous, flat-tapped and steep sided ridge that stands out distinctly on the plain. Further south another tongue, crossed by the Jedda-Medina road (Pl. V, B), has nearly reached the sea near Al-Kura' (30 kms. north of Jedda). North of Rabigh another tongue forms a clear-cut mesa-like ridge.

Accordance of summit-levels :

Individual landforms are not the only major concern of a student of geomorphology. The general lineaments of the landscape are at least equally important. To an examination of a number of these we may now turn.

A first remarkable feature of regional extent is the striking accordance of summit-levels that is displayed in vast areas of the interior. Such is the picture to be gained from the top of the Dhira mountain overlooking Abha in a view towards the east, and from many other vantage points in the Asir plateau (Pl. VI, A). Some summits, however, rise in a more or less isolated manner above the general surface-plane. In Hejaz the feature is not so easily recognized, since extensive parts of the interior have here been invaded by subsequent lava flows which obscure the original relief. From this general accordance of summit-levels, maintained, as it is, across surfaces of varying lithological composition it may be inferred that the initial surface of the present cycle of erosion was a peneplain (which in now gently tilted north-eastwards). The isolated higher summits should represent monadnocks that have not yet been consumed.

Precisely the same topographical situation is discernible in the interior of N. Ethiopia. We have also noticed the same feature in the southern part of the Eastern desert of Egypt on viewing this country from the edge of the Libyan plateau overlooking the Nile near Aswan.

Here then is a feature of wide extension, though, in the present state of knowledge, we cannot attempt to explain the earlier stages of erosion in the region. It may be of some advantage to mention that such an attempt was made in the case of Eritrea. There, it is maintained that the current cycle of erosion operating in the interior plateau was inaugurated by the Tertiary (Possibly Late Eocene) regional uplift that preceded the great dislocations which brought about the Red Sea basin. Prior to the Tertiary the land-surface passed through a complete cycle of erosion only during the Palaeozoic era, since neither morphological nor geological considerations warrant an assumption of a multiplicity of cycles of erosion such as has been claimed by some investigators [1].

In Western Arabia, however, the available facts cannot allow of an even tentative exposition of the denudational chronology, and we must be content with the single foregoing conclusion, namely, that the present cycle of erosion in the interior was inaugurated on a peneplained surface.

Origin of major altitudinal differences :

The general morphological edifice of Western Arabia is an outcome of its petrology and structure, while climate plays a relatively limited role in this respect. That this part of Arabia generally attains a great altitude is due both to the high resistance of the igneous complex as a whole and to tectonic uplifting.

Neither process nor stage will explain the major differences in altitude that present themselves. The Asir plateau is more elevated than the drier Hejaz mountains, attaining as it does about 2200 metres above

[1] Abul-Haggag, Y., *A Contribution to the Physiography of Northern Ethiopia*, University of London (The Athlone Press), London, 1961, Chapters IX and X. For a summarised exposition, see « On the Morphology of the Eastern Margin of the Central North Ethiopian Plateau », by the author, in T. XXXII (1959) of this *Bulletin*.

sea-level in Abha, + 2500 metres in wide segments of the western part of the plateau as *e.g.* in the Tamniya plateau and the neighbouring country extending to the east and in the Bani Malek country north of Abha, and even soaring to more than 2900 metres in the Suda mountain north-west of Abha. Elevations in Hejaz are generally smaller, inspite of the slower tempo of erosion in such an arid land.

Again, within Hejaz itself, certain major altitudinal differences are to be noted. Thus while in the extreme north-west, *i.e.* to the east of the Gulf of Aqaba, most of the land-surface rises to 1000-2000 metres above sea-level and, in places, to elevations comparable to those of the higher Asir mountains, as *e.g.* Jabal Al-Lawz (2580 m.), the country extending roughly between the Medina and Mecca areas rises to only 1000 metres and less in most parts (Medina 639 m.; Mecca 328 m. with Jabal Khandama, the highest of the encircling mountains, rising to only about 1000 m. above sea-level). Because of its relatively modest altitude, coupled with its position in the 'waist' of the peninsula, the latter country has incidentally, always been the best western gateway to central Arabia.

Now these major altitudinal differences cannot be explained by climate or by lithological variations. We are left with the only assumption that they are the outcome of tectonic factors. These can be either related to the original faulting movements which formed the Red Sea graben, that is, to variable vertical displacements, or to inequalities of the upwarping movement which preceded the rifting. Neither of these two tectonic movements can so far be given more weight than the other. It may, however, be stated that investigations in Eritrea on the other side of the Red Sea tend to confirm that similar major differences of altitude are to be associated with the variable degree of uplifting which occurred before the formation of the Eritrean Trench [1].

The Great Asiri Escarpment :

Rejuvenation of faulting along the western border of the higher segments is another possibility to be invoked, at least as a contributing

(1) ABUL-HAGGAG, Y., «A Contribution etc.», *op. cit.*, pp. 81-82.

factor. Although triangular faceted spurs do not constitute a feature of any prominence along the West-Arabian scarps the contrast between Asir and Hejaz in scarp-development is striking. The Asir plateau is limited on the west by a veritable escarpment of strong inclination and great height. No such main escarpment exists in western Hejaz, the country being, instead, broken into a labyrinth of mountains, either isolated or in clusters. In a distant view from the coastal plain a semblance of a high escarpment is to be noticed in places, but, on approaching the mountainland, the scene proves to be one of a vigorously dissected country, without a distinct continuous scarp that can be compared with the imposing Asiri wall.

This great escarpment of Asir is a prominent feature from the air. From the land it can be well noticed from Sheddad (near Arafat) on looking towards the Taif plateau, and, better still, from many points along the rim of the Asir plateau (as *e.g.* near Abha and Sha'ar) where the land-surface is seen to drop abruptly hundreds of metres, with the dissecting wadis plunging down through deep ravines on their way to the Red Sea (PL. VI, B).

Yet the assumption of a rejuvenation of faulting which may explain this precipitous escarpment and may have contributed to upraising the Asir plateau to its present altitude should not be taken to mean that we are dealing with an original fault-face. Inspite of the general rectilinearity of its trend, the Asiri escarpment is essentially an erosional feature : a retreating scarp. On account of its strong declivity and relative abundance of rain the escarpment face has been vigorously attacked by river erosion. The wadis rushing towards the Red Sea are actively engaged in extending their valleys by retrogressive erosion, thus breaching the crest in many localities (PL. VII). Some of these torrents have even managed to push their source reaches some distance into the interior, beyond the main divide-line, as has been done by affluents of both the Itwood torrent in the Abha area and Wadi Tayya in the Sha'ar plateau. This is reminiscent of conditions in Eritrea where in the Senafé zone, for instance, an affluent of a seaward flowing torrent has succeeded in pushing its head beyond the eastern edge of the plateau [1]. As in

(1) ABUL-HAGGAG, *op. cit.*, p. 107.

Eritrea, too, large segments of country that have been partly or completely isolated from the plateau rise to the same height as the present escarpment crest. In places they are even higher, as *e.g.* in the Sha'ar zone.

These considerations tell evidently against any assumption of an original fault-scarp. The postulated rejuvenation of faulting should not, therefore, be regarded as a recent occurrence.

Stepped Topography :

Another morphological feature that came under our notice, particularly in Hejaz, is the stepped topography of the western flanks of the highlands, *i.e.* the storeyed succession of two belts of country, both well dissected and of distintly varying elevations. The feature is discernible in many localities, as *e.g.* along the western scarp of Jabal Radwa north-east of Yanbu Al-Bahr, in the Badr area further south and east of Jedda. The accompanying panorama (fig. 4) serves to give an idea of this particular landscape.

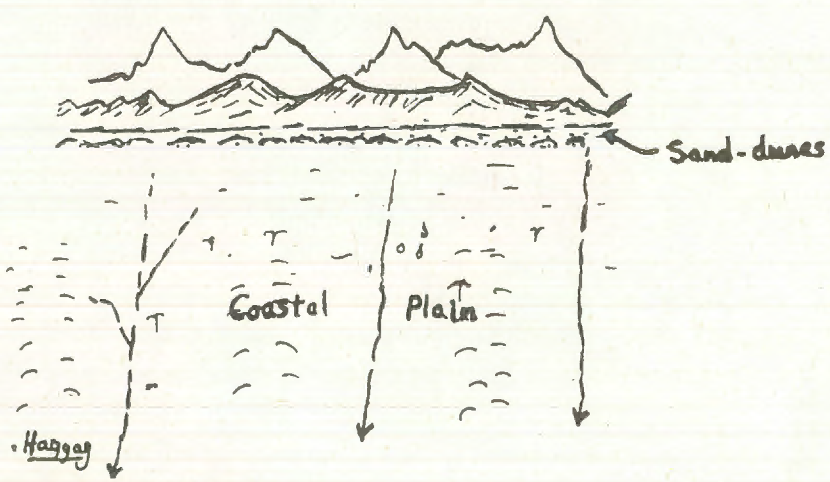


FIG. 4. Stepped topography in Hejaz. View from coastal plain south of Yanbu. Note dissection in both steps, and the rectilinear trend of the scarps.

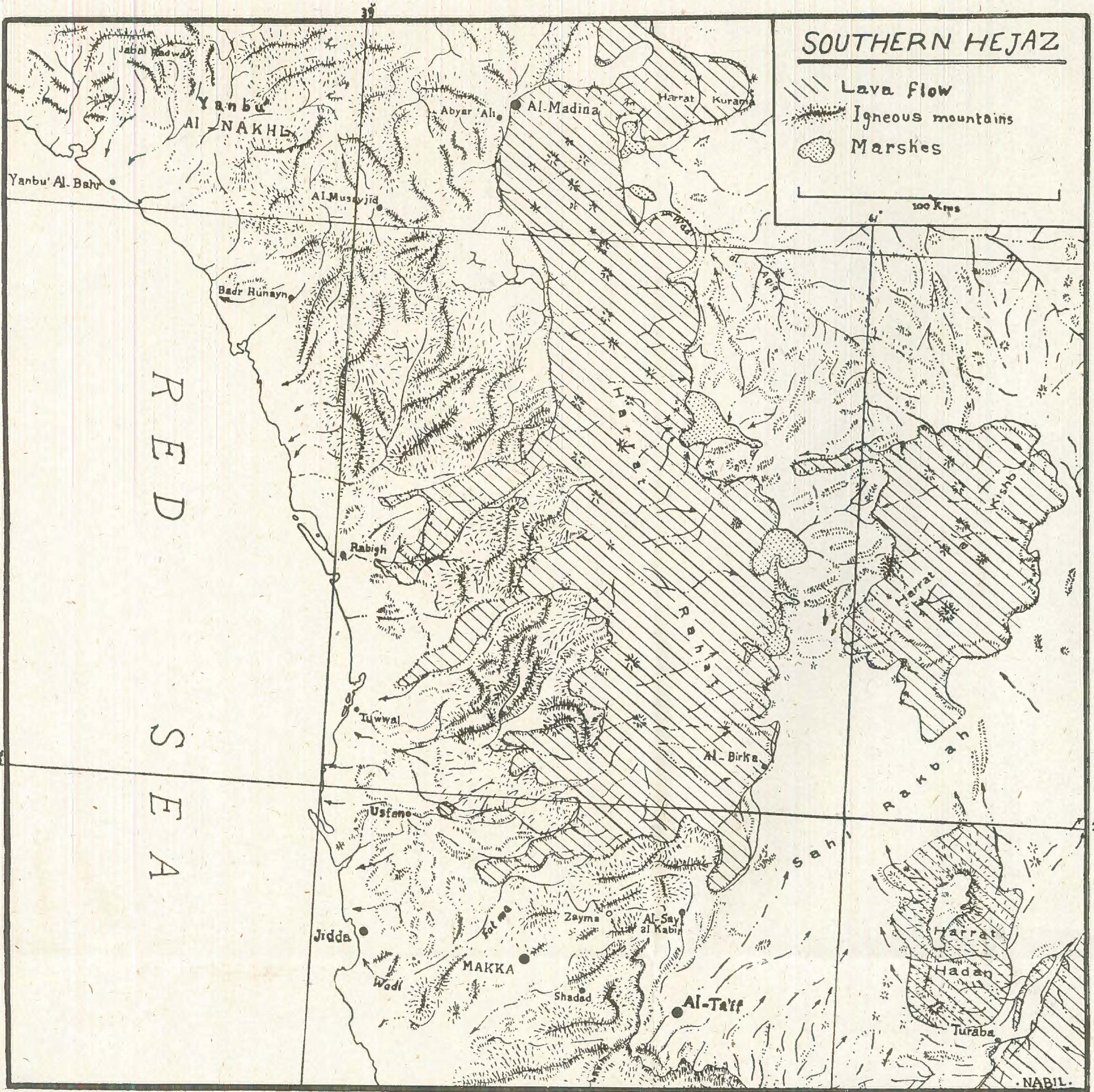
The explanation of this disposition lies probably in step-faulting, rather than in cyclic benching reflecting intermittent uplift. An important remark in this connection is that stepped topography is not strictly

limited to the western part bordering the coastal lowlands. It is also exhibited *within* the Hejaz mountainland, as can be plainly seen from the air in a flight over the tract extending east of the Jedda area. Scarp retreat may be contemplated, but in view of the unhomogeneity of rocks in the igneous complex, it cannot be taken as a satisfactory explanation. It may also be added that rectilinear trends of the scarp-faces constitute a frequent feature, and that in many instances these scarps extend along a N.-S. or N.W.-S.E. axis. An example is the remarkably straight, generally N.-S. trending scarp to be seen in the upper Wadi Fatma area near the Taïf aerodrome (27 kms. north-east of Taïf). It overlooks the south-western corner of the Rakba plain which extends to the east with a prominent, very steep-sided face. It is also noteworthy that the main axis of the major lava fields of Hejaz strikes N.W.-S.E., *i.e.* parallel to the general axis of the Red Sea graben. Another relevant remark is that stepped topography is of a local nature. It does not extend throughout the western borderland, which is evidently incompatible with the assumption of a regional intermittent uplift.

If on these grounds step-faulting is to be preferred as the origin of stepped topography-an origin which incidentally has been postulated to explain a similar feature in the southern sector of the Eastern Slopes in Eritrea [1] it is not to be thought that we are dealing with recent faults. The lava-covered areas apart, dissection has manifestly gone a long way in the Hejaz mountainland.

[1] ABUL-HAGGAG, *op. cit.*, pp. 103, 128-132.

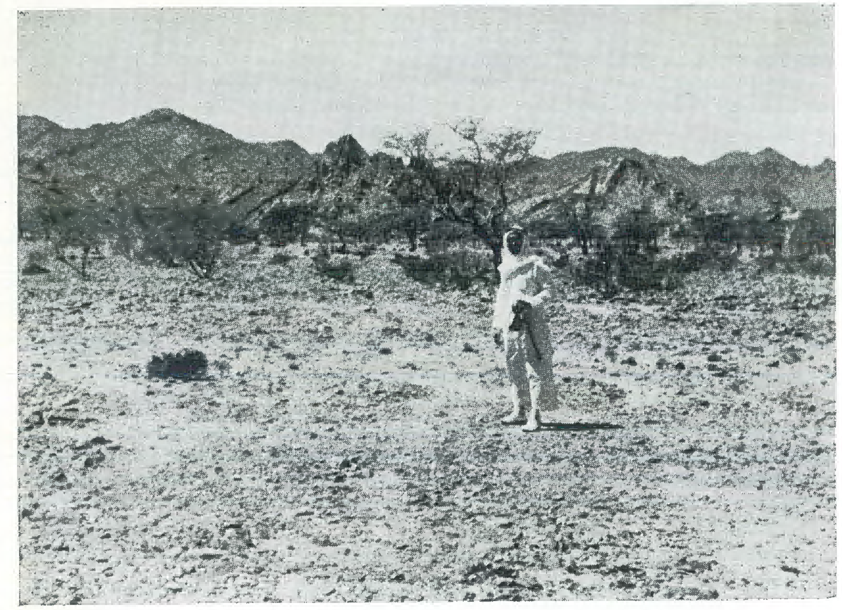
MAP 1



SOUTHERN HEJAZ
Lava flow
Igneous mountains
Marshes
100 Kms
Jabal Radwa
Yanbu'
Al NAKHL
Yanbu' Al Bahr
Al Musayjid
Abyar Ali
Al-Madina
Harrat Kuram
Badr Hunayn
RED SEA
Rabigh
Tuwwal
Usfane
Jidda
MAKKA
Zayma
Al-Sayl al Kabir
Shadad
Al-Ta'if
Harrat Rahat
Al-Birka
Harrat Kishb
Sahl Rakbah
Harrat Hadan
Turaba
NABIL.

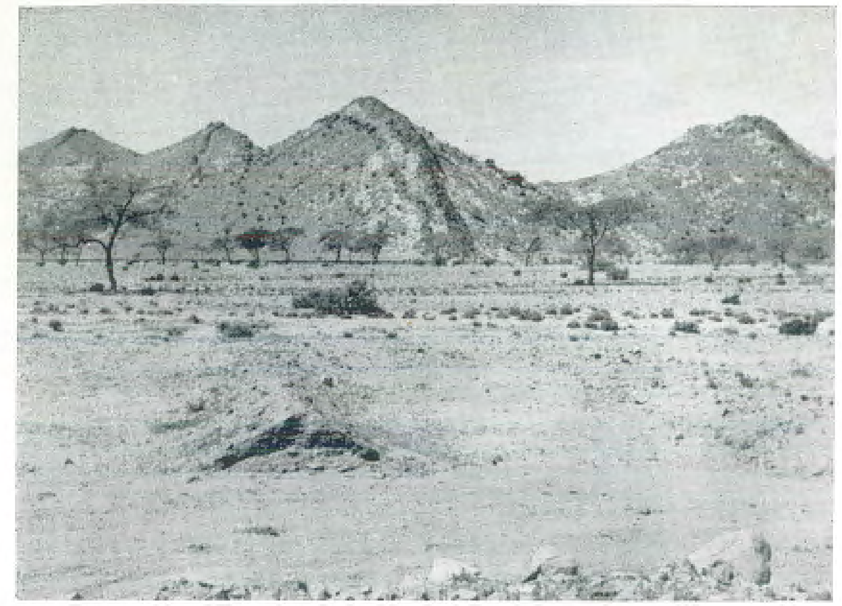
MAP 2

Al-Ta'if
Turaba
Harrat Nawasif
Ranyah
Harrat Buqum
Bisha
Bilad Zahran
Al-Lith
Bilad Ghamid
Al-Zafir
Qal'at Bisha
Wadi Bisha
RED SEA
Al-Qunfida
2508
Numas
Hali
Wadi Tayya
Al-Sheer
Jabal Sawda
Khamis Mushayt
Wadi
Abha
Suq Al-Ahad
Yazida
Lihaf
Suq Al-Ithnein
Wadi Tathlith
Baysh
Zahran
SAUDI ARABIA
YEMEN
Jizan
NABIL
41°
43°
20°
18°
ASIR & TIHAMA
Lava flow
Igneous mountains
Escarpment
100 kms



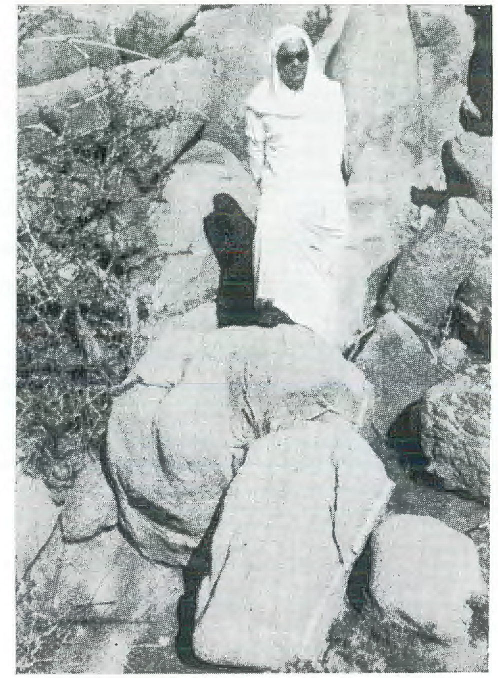
A. — A flat-lying intermontane basin between the Abyar Ali and Museijīd areas in Hejaz (Medina-Jedda road).

B. — The rugged mountains west of Medina, Hejaz.

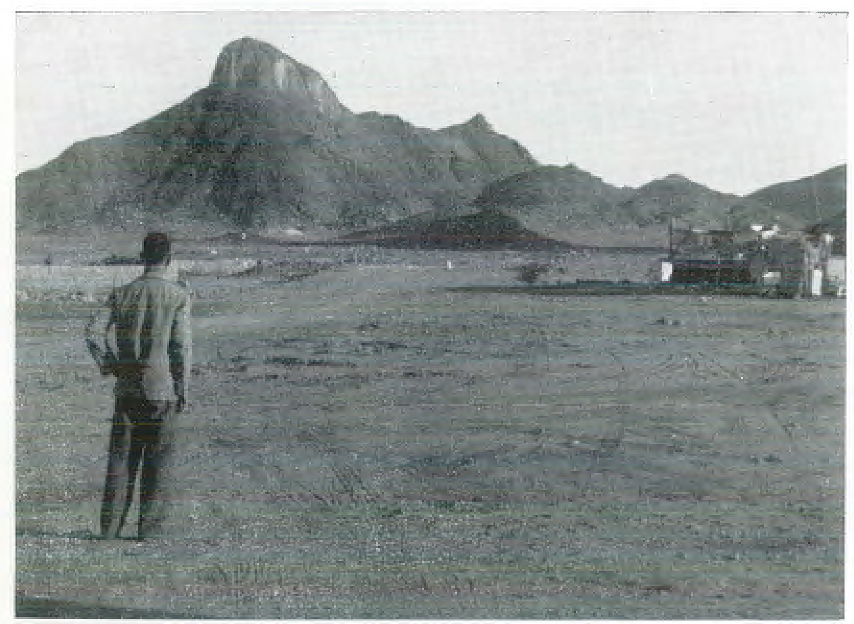


A. — Folded igneous hills between Abyar Ali and Musrijīd, Hejaz.

B. — A rounded granite block in the Qaraʿa area (Asir plateau). Note the exfoliation and the different forms in the blocks in the background.



A. — Eroded granite in the Mecca-Zayma area.



B. — Gebel Al-Nur, near Mecca.

A. — View north of Abha area, showing steeply inclined schist outcropping at ground level, and relative of slopes in metamorphic mountains.

B. — Homoclinal ridges in schistose terrain. View in Shaʿar area (Asir plateau).

A. — Fresh, almost intact, lava flow in the Aqul area near Medina.

B. — Fragmented lava in the extremity of a lava tongue, south of Rabigh, in Hejaz.

A. — View from old Shaʿar fort looking N. 45 E. Note the general accordance of summit-levels and the convexity of slopes.

B. — The precipitous Asiri escarpment at head of Wadi Tayya (Asir plateau).

Active headward erosion by an affluent of a seaward flowing torrent (Tamniya plateau, Asir). Roots of the trees (junipers) exposed by the process are seen in the middle ground.

RECHERCHES SUR L'ORIGINE
DU
PEUPLEMENT DE LA CYRÉNAÏQUE
D'APRÈS L'ÉTUDE DE LA STRUCTURE CÉPHALIQUE

PAR

ROBERT-P. CHARLES

INTRODUCTION

Les modernes habitants de la Cyrénaïque sont bien connus grâce aux recherches poursuivies par les savants italiens [1] de 1920 à 1940. Dans la présente étude, nous avons utilisé les mensurations individuelles publiées par Puccioni [2] à la suite de son enquête des années 1928-1929, et nous avons classé les sujets en suivant la méthode que nous avons exposée dans un précédent volume de ce *Bulletin* [3]; toutefois, Puccioni n'ayant pas donné dans ses tableaux, la hauteur de la partie supérieure de la face, nous n'avons pu calculer ni l'indice céphalo-facial structural, ni l'indice facial supérieur, ni le module facial supérieur; de ce fait nous n'avons pu nous servir de la clef dichotomique établie sur les bases de notre précédente étude, et nous avons dû en composer une autre, en nous fondant sur divers critères, autres que ceux utilisés alors.

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(1) Cf. Nello PUCCIONI, Bèrberi e Arabi nell'Africa mediterranea, *in* Renato BIASUTTI, Razze e Popoli della Terra, 2e éd., Turin, 1955, vol. III, pp. 109-126.

(2) Nello PUCCIONI, Antropometria delle Genti della Cirenaica, Florence, 1936.

(3) Robert-P. CHARLES, Considérations sur la structure céphalique des populations du district occidental d'Egypte, *Bull. Soc. de Géogr. d'Egypte,* t. XXXV, 1962, spécialement pp. 14-19.

Sans présenter la même rigueur que la clef précédente, celle-ci permet néanmoins de déterminer les types structuraux dans de bonnes conditions, en procédant comme suit :

Ire Opération. Considérer l'indice céphalo-facial physionomique :

si l'indice est au plus égal à 79,9 passer à la IIe opération;
si l'indice vaut de 80,0 à 83,5 passer à la IIIe opération;
si l'indice est au moins égal à 83,6 passer à la IVe opération.

IIe Opération. Le sujet est chamæprosope; considérer l'indice nasal :

si l'indice est au plus égal à 69,9 le sujet appartient au groupe A;
si l'indice est au moins égal à 70,0 le sujet appartient au groupe AB.

IIIe Opération. Le sujet est métrioprosope; considérer l'indice nasal :

si l'indice est au plus égal à 69,9 le sujet appartient au groupe AC;
si l'indice vaut de 70,0 à 84,9 le sujet appartient au groupe BC;
si l'indice est au moins égal à 85,0 le sujet appartient au groupe B.

IVe Opération. Le sujet est hypsiprosope; considérer le diamètre bizygomatique :

si ce diamètre est au plus égal à 137,9 chez les hommes, et à 126,9 chez les femmes, passer à la Ve opération;
si ce diamètre est au moins égal à 138 chez les hommes, et à 127 chez les femmes, passer à la VIe opération.

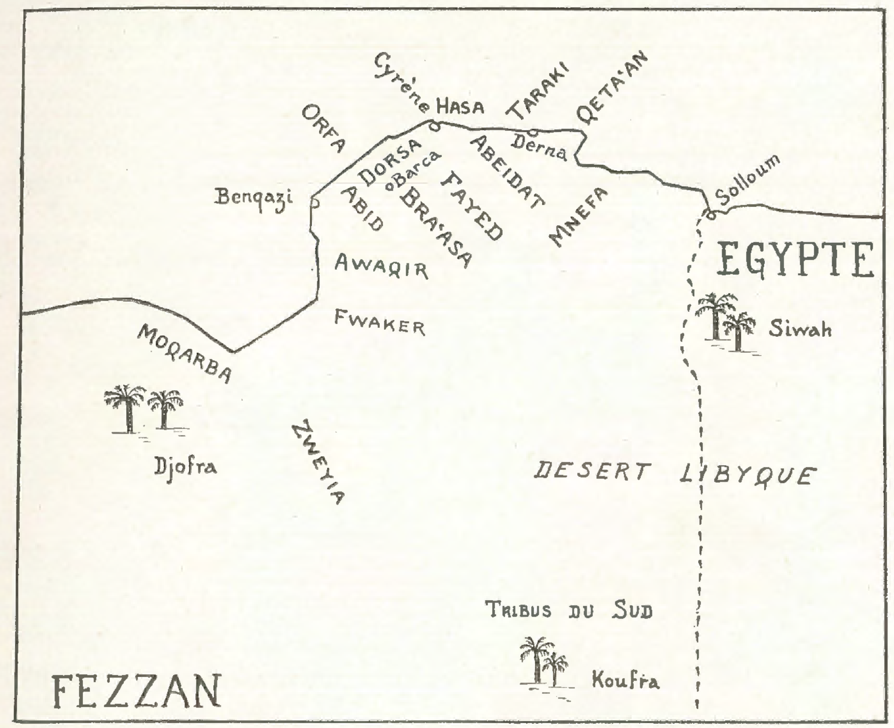
Ve Opération. Le sujet est hypsiprosope avec la face relativement étroite; considérer l'indice nasal :

si l'indice est au plus égal à 69,9 le sujet appartient au sous-groupe (ABC)-AC du groupe AC;
si l'indice est au moins égal à 70,0 le sujet appartient au sous-groupe (ABC)-BC du groupe BC.

VIe Opération. Le sujet est hypsiprosope avec la face relativement large; considérer l'indice nasal :

si l'indice est au plus égal à 84,9 le sujet appartient au groupe ABC;
si l'indice est au moins égal à 85,0 le sujet appartient au sous-groupe (ABC)-B du groupe B.

Ainsi que nous l'avions déjà fait remarquer à l'occasion de notre précédente étude, l'appréciation métrique de la hauteur de la voûte crânienne sur le vivant étant entâchée de subjectivité, nous n'avons pas tenu compte des indices calculés en utilisant cette mesure; de ce fait, nous n'avons



déterminé pour chaque individu le type structural principal, sans rechercher les possibilités d'hybridation qui n'ont certainement pas manqué de se produire.

ÉTUDE SYSTÉMATIQUE DES GROUPES

Afin de ne pas allonger cet article, nous ne reprendrons pas la diagnose de chaque groupe, nous contentant de renvoyer à notre précédente étude. Nous indiquerons seulement les paramètres établis statistiquement pour chaque indice dans chacun des groupes structuraux, et nous noterons les différences éventuelles avec les homologues établis pour l'Egypte occidentale.

Groupe ABC : Paléo-kamitique

(cf. *op. cit.,* 1962, pp. 20-25)

Nous avons classé dans ce groupe, 145 sujets se répartissant d'après les valeur de l'indice céphalique :

si l'indice est au plus égal à 75,9 (dolichocéphale) : type ABC_1, 99 sujets ;

si l'indice vaut de 76,0 à 80,9 (mésocéphale) : type ABC_2, 43 sujets ;

si l'indice est au moins égal à 81,0 (brachycéphale) : type ABC_3, 1 sujet.

L'étude statistique nous a permis d'établir pour ce groupe, les caractères anthropométriques moyens suivants :

Indices	m	σ	Caractéristiques
céphalo-facial transversal	95,4	2	macropside
céphalo-facial physionomique	84,8	1,6	hypsiprosope (par définition)
facial total	89,5	3,5	leptoprosope
nasal.	63,6	4,2	leptorhinien (par définition)

Si l'on compare ces chiffres à ceux que nous avions obtenus pour le groupe ABC en Egypte occidentale, les différences sont minimes: on doit simplement noter qu'en Cyrénaïque, il y a une plus grande fréquence de sujets à face large par rapport au crâne, et de ce fait moins étroites dans ses proportions ; une autre incidence de cette particularité est que le nez est généralement moins étroit.

Le sujet d'une tribu Hasa, figuré par Puccioni (in Biasutti, *op. cit.,* 1955, p. 120, fig. 86 en bas) peut être considéré comme un excellent exemple du groupe paléo-kamitique.

Groupe AC : Sub-méditerranéen

(*op. cit.,* 1962, pp. 25-33)

Nous avons classé dans ce groupe, 177 sujets se répartissant d'après la valeur de l'indice céphalique :

1° dans le sous-groupe africain (diamètre bizygomatique au moins égal à 138 chez les hommes et 127 chez les femmes) :

si l'indice est au plus égal à 75,4 type kamitique (AC_1) : 26 sujets ;

si l'indice vaut de 74,5 à 81,4 type libyco-berbère (AC_2) : 50 sujets ;

si l'indice est au moins égal à 81,5 type berbéro-tellien (AC_3) : 3 sujets.

2° dans le sous-groupe asiatique (diamètre bizygomatique au plus égal à 137,9 chez les hommes et 126,9 chez les femmes) :

si l'indice est au plus égal à 75,4 type sud-oriental (AC_1) : 47 sujets ;

si l'indice vaut de 75,5 à 81,4 type syro-cananéen (AC_2) : 49 sujets ;

si l'indice est au moins égal à 81,5 type syro-arménoïde (AC_3) : 2 sujets.

L'étude statistique nous a permis d'établir pour ce groupe, les caractères anthropométriques moyens suivants :

Indices	m	σ	Caractéristiques
céphalo-facial transversal	93	3	méso à macropside
céphalo-facial physionomique	81,7	0,7	métrioprosope (par définition)
facial total	86,2	3,1	mésoprosope
nasal.........................	63,4	2,8	leptorhinien (par définition)

Si l'on compare ces chiffres à ceux que nous avions obtenus pour le groupe AC en Egypte occidentale, on remarque que les différences sont minimes ; tout-au-plus doit-on noter qu'en Cyrénaïque, les sujets possèdent avec une plus grande fréquence, une face plus large par rapport au crâne, et de ce fait moins étroite dans ses proportions.

Le sujet figuré par Puccioni (in Biasutti, *op. cit.,* 1955, p. 123, fig. 89) est un excellent exemple du type libyco-berbère (toutefois, ce sujet a été photographié à Djado en Tripolitaine, et non en Cyrénaïque), et le sujet d'une tribu Taraki (in *ibid.,* p. 121, fig. 87 en haut) est un excellent exemple du type sud-oriental.

Sous-groupe (ABC)-AC : Sub-anatolien

(*op. cit.*, 1962, pp. 33-37)

Nous avons classé dans ce sous-groupe, 129 sujets se répartissant d'après la valeur de l'indice céphalique :

si l'indice est au plus égal à 75,4 type nord-syrien, (ABC)-AC_1 : 89 sujets ;

si l'indice vaut de 75,5 à 81,4 type cilicien, (ABC)-AC_2 : 40 sujets ;

si l'indice est au moins égal à 81,5 type arménoïde, (ABC)-AC_3 : néant.

L'étude statistique nous a permis d'établir pour ce sous-groupe, les caractères anthropométriques moyens suivants :

Indices	m	σ	Caractéristiques
céphalo-facial transversal	93,4	2,3	méso à macropside
céphalo-facial physionomique	85,1	2,5	hypsiprosope (par définition)
facial total	91,4	2,8	leptoprosope
nasal	60,5	2,9	leptorhinien (par définition)

Si l'on compare ces chiffres à ceux que nous avions obtenus pour le sous-groupe (ABC)-AC en Egypte occidentale, on ne note que des différences insignifiantes, et même négligeables. Ceci met bien en évidence que les sujets classés ici ont bien une origine identique (sub-anatolienne), étrangère à la Cyrénaïque comme à l'Egypte.

Le sujet d'une tribu Abeidat, figuré par Puccioni (in Biasutti, *op. cit.*, 1955, p. 126, fig. 87 en bas) qui lui reconnaît avec justes raisons des affinités iraniennes, est un excellent exemple du type nord-syrien.

Groupe A : méditerranéen (cromagnoïde)

(*op. cit.*, 1962, pp. 37-42)

Nous avons classé dans ce groupe, 186 sujets se répartissant d'après la valeur de l'indice céphalique :

si l'indice est au plus égal à 76,9 type méditerranéen ancien (A_1) : 93 sujets ;

si l'indice vaut de 77,0 à 81,9 type alpino-méditerranéen (A_2) : 87 sujets ;

si l'indice est au moins égal à 82,0 type alpinoïde (A_3) : 6 sujets.

L'étude statistique nous a permis d'établir pour ce groupe, les caractères anthropométriques moyens suivants :

Indices	m	σ	Caractéristiques
céphalo-facial transversal	92,5	2,6	mésopside
céphalo-facial physionomique	78,1	2,7	chamæprosope (par définition)
facial total	83,5	2,5	eury à mésoprosope
nasal	66,0	3,1	leptorhinien (par définition)

Si l'on compare ces chiffres à ceux que nous avions obtenus pour le groupe A en Egypte occidentale, on remarque que les différences sont très faibles ; tout-au-plus peut-on noter que la face est ici un peu moins étroite par rapport au crâne, et de ce fait elle est plus large dans ses proportions ; comme elle est fréquemment moins basse, cela tend à mettre en évidence qu'en Cyrénaïque, les sujets du groupe A ont la face plus développée que ceux que l'on doit classer dans le même groupe en Egypte. Nous avions vu que ceux-ci étaient d'origine surtout libanaise ; nous verrons plus loin qu'en Cyrénaïque, les sujets du groupe A sont surtout d'origine ionio-anatolienne.

Le sujet d'une tribu Bra'asa, figuré par Puccioni (in Biasutti, *op. cit.*, 1955, p. 122, fig. 88) est un excellent exemple du type alpino-méditerranéen, tel qu'il est représenté en Cyrénaïque.

Groupe AB : Nord-saharien

(*op. cit.*, 1962, pp. 42-44)

Nous avons classé dans ce groupe, 157 sujets se répartissant d'après la valeur de l'indice céphalique :

si l'indice est au plus égal à 75,9 type nord-saharien (AB_1) : 75 sujets ;

si l'indice vaut de 76,0 à 80,9 type saharien (AB_2) : 74 sujets;

si l'indice est au moins égal à 81,0 type saharien des oasis (AB_3) : 8 sujets.

L'étude statistique nous a permis d'établir pour le groupe AB, les caractères anthropométriques moyens suivants :

Indices	m	σ	Caractéristiques
céphalo-facial transversal	93,6	2,8	méso à macropside
céphalo-facial physionomique	76,4	1,6	chamæprosope (par définition)
facial total	81,6	3,2	euryprosope
nasal	74,4	2,2	mésorhinien (par définition)

En Egypte occidentale, nous n'avions déterminé que 19 sujets du groupe AB ; de ce fait, il avait été impossible d'établir les caractéristiques par la méthode statistique. L'étude que nous venons d'entreprendre, nous permet donc de combler cette lacune, et de vérifier que les sujets que nous avions précédemment classés dans ce groupe, ne s'écartent pas des normes que nous venons d'établir.

Le sujet photographié à Tripoli, figuré par Puccioni (in Biasutti, *op. cit.*, 1955, p. 119, fig. 85 à gauche) est un excellent exemple du type saharien ; ce sujet est leucoderme, ce qui le fait qualifier de « berbéroïde» par Puccioni, mais chez les autres sujets de ce groupe, tous les degrés de pigmentation sont attestés sans que cela implique le métissage.

Groupe BC : Nilotique

(*op. cit.*, 1962, pp. 44-47)

Nous avons classé dans ce groupe, 63 sujets se répartissant d'après la valeur de l'indice céphalique :

si l'indice est au plus égal à 75,9 type nord-nilotique (BC_1) : 42 sujets ;

si l'indice vaut de 76,0 à 80,9 type nubien (BC_2) : 20 sujets;

si l'indice est au moins égal à 81,0 type nubien des oasis (BC_3) : 1 sujet.

L'étude statistique nous a permis d'établir pour le groupe BC, les caractères anthropométriques moyens suivants :

Indices	m	σ	Caractéristiques
céphalo-facial transversal	94,5	2,1	macropside
céphalo-facial physionomique	81,4	0,8	métrioprosope (par définition)
facial total	85,0	2,0	mésoprosope
nasal	73,3	1,6	mésorhinien (par définition)

En Egypte occidentale, nous n'avions déterminé que 45 sujets de ce groupe ; la présente série, plus importante, permet de préciser les caractéristiques. Les sujets de Cyrénaïque se présentent avec une plus grande fréquence de faces larges par rapport au crâne, et de ce fait moins étroites dans leurs proportions.

Sous-groupe (ABC)-BC : Kamito-nilotique

(*op. cit.*, 1962, pp. 47-50)

Nous avons classé dans ce sous-groupe, 40 sujets se répartissant d'après la valeur de l'indice céphalique :

si l'indice est au plus égal à 75,9 type kamito-nilotique, (ABC)-BC_1 : 32 sujets ;

si l'indice vaut de 76,0 à 80,9 type kamito-nubien, (ABC)-BC_2 : 7 sujets ;

si l'indice est au moins égal à 81,0 type kamito-nubien des oasis, (ABC)-BC_3 : 1 sujet.

Bien que la série soit un peu faible, il a été possible d'établir les caractères anthropométriques moyens de ce sous-groupe :

Indices	m	σ	Caractéristiques
céphalo-facial transversal	93,3	1,9	méso à macropside
céphalo-facial physionomique	85,0	1,3	hypsiprosope (par définition)
facial total	91,0	1,8	leptoprosope
nasal	73,1	2,0	mésorhinien (par définition)

En Egypte occidentale, nous n'avions déterminé que 22 sujets de ce sous-groupe. La présente série permet de préciser les caractéristiques, et de vérifier que les sujets d'Egypte ne s'écartent pas des normes que nous venons d'établir.

Le sous-groupe (ABC)-BC constitue une entité homogène que les sujets soient originaires d'Egypte ou de Cyrénaïque.

Groupe B : Soudanais

(*op. cit.*, 1962, pp. 50-51)

Nous avons classé dans ce groupe 19 sujets se répartissant d'après la valeur de l'indice céphalique :

si l'indice est au plus égal à 75,9 type soudanais (B_1) : 15 sujets ;
si l'indice vaut de 76,0 à 80,9 type soudano-saharien (B_2) : 4 sujets ;
si l'indice est au moins égal à 81,0 (B_3) : non rencontré jusqu'ici.

Bien que la série soit faible, il a été possible d'établir les caractères anthropométriques moyens avec une approximation suffisante :

Indices	m	σ	Caractéristiques
céphalo-facial transversal	96,1	1,3	macropside
céphalo-facial physionomique	81,3	1,3	métrioprosope (par définition)
facial total	84,5	1,7	eury à mésoprosope
nasal	90,5	2,3	platyrhinien (par définition)

En Egypte occidentale, nous n'avions déterminé que 6 sujets du groupe B, qui sont bien dans les limites des normes que nous venons d'établir.

Les sujets du groupe B sont des négroïdes véritables, non autochtones dans les régions considérées dans cette étude, et originaires de l'Afrique noire.

Sous-groupe (ABC)-B : Kamito-soudanais

(*op. cit.*, 1962, p. 52)

Nous avons classé dans ce sous-groupe, 14 sujets se répartissant d'après la valeur de l'indice céphalique :

si l'indice est au plus égal à 75,9 type kamito-soudanais (ABC)-B_1 : 9 sujets ;

si l'indice vaut de 76,0 à 80,9 type kamito-saharien (ABC)-B_2 : 5 sujets ;

si l'indice est au moins égal à 81,0 (ABC)-B_3 non rencontré jusqu'ici.

Nous ne disposons pas pour ce sous-groupe, d'une série suffisante pour permettre une étude statistique ; il est néanmoins possible d'indiquer les caractères anthropométriques de la majorité des sujets en rassemblant les résultats dans un tableau :

Indices		Caractéristiques
céphalo-facial transversal	96-100	hypermacropside
céphalo-facial physionomique	85-90	hypsiprosope (par définition)
facial total	87-89	méso à leptoprosope
nasal	86-90	platyrhinien (par définition)

Nous n'avions trouvé qu'un seul sujet à classer dans le sous-groupe (ABC)-B en Egypte occidentale. Comme pour les sujets du groupe B *sensu stricto*, ceux-ci sont des négroïdes véritables, et leur présence dans les régions qui font l'objet de la présente étude, sont le témoignage d'une venue de population originaire de l'Afrique noire.

COMPOSITION DE LA POPULATION

L'enquête faite en 1928-1929 portant sur des sujets adultes, ceux-ci sont nés à une époque où la Cyrénaïque était encore une dépendance nominale de la Sublime Porte. L'organisation tribale avait encore sa pleine valeur; aussi, bien que les territoires propres à chaque tribu soient très rapprochés les uns des autres, nous avons conservé ces divisions traditionnelles de la population, et les ensembles vont être considérés successivement en nous déplaçant d'ouest en est.

Tribus de la côte occidentale

L'ensemble de la documentation réunie sur cette région a été rassemblé dans le tableau I. Sauf indication contraire, il s'agit toujours de sujets masculins; la documentation sur chaque tribu est quelquefois insuffisante, et toujours inégale d'une tribu à l'autre, aussi nous ne discuterons guère que sur l'ensemble des tribus de chaque région.

Ainsi que nous l'avions signalé à l'occasion de notre précédente étude, la véritable unité systématique étant représentée par le groupe et non par le type, il y a lieu de considérer ceux-ci dans leur ensemble.

Sur 166 sujets étudiés, le groupe AC prédomine très nettement, avec 68 sujets représentant 41% de la population de Cyrénaïque occidentale : au sein de cet ensemble, il y a lieu de distinguer, 16 sujets d'affinité africaine (9,64%), 25 sujets d'affinité cananéenne (15,05%), et 27 sujets d'affinité sub-anatolienne (16,28%); le groupe A, avec 29 sujets, représente 17,49% de la population; le groupe AB, avec 28 sujets, 16,88 °/₀ de la population; le groupe ABC, avec 27 sujets, 16,26%, et le groupe BC enfin, avec 12 sujets, seulement 7,22% de la population.

En sélectionnant les sujets d'après leurs affinités géographiques, on peut distinguer :

1. *Eléments strictement méditerranéens.* Ce sont les sujets du groupe A, au nombre de 29, représentant 17,49% de la population.

TABLEAU I — Tribus de la Côte Occidentale de Cyrénaïque

Groupes et types structuraux		Moqarba		Fwaker	Awaqir				Abeid			Total	
		♂	♀		Brahim	Sdeidi	Mtawa	♀	Mansour	Djaber	♀		
ABC,													
Paléokamitiques	dolichocéphales	2	—	1	4	1	3	3	3	4	1	22	13,25 %
	mésocéphales	—	—	—	—	2	1	—	1	1	—	5	3,01
AC, africains :	Kamitiques	—	—	—	—	—	1	—	1	—	—	2	1,20
	Libyco-berbères	1	—	1	1	2	1	—	2	4	1	13	7,83
	Berbéro-tellien	—	—	—	—	—	—	1	—	—	—	1	0,60
AC, asiatiques :	Sud-orientaux	3	—	2	1	1	—	—	—	2	1	10	6,02
	Syro-cananéens	3	—	1	1	3	3	2	1	1	—	15	9,03
(ABC)-AC.	Nord-syriens	—	1	3	3	2	—	—	5	1	—	15	9,03
	Ciliciens	3	1	1	—	1	3	—	1	1	1	12	7,22
A.	Méditerranéens anciens	1	2	—	1	3	1	1	2	2	—	13	7,83
	Alpino-méditerranéens	4	—	—	—	2	2	—	2	1	2	13	7,83
	Alpinoïdes	—	—	—	—	1	1	—	—	—	1	3	1,81
AB.	Nord-sahariens	2	—	5	4	—	1	2	—	1	—	15	9,03
	Sahariens	—	1	3	1	2	1	1	—	1	1	11	6,63
	Sahariens des Oasis	—	1	1	—	—	—	—	—	—	—	2	1,20
BC.	Nord-nilotiques	—	—	—	3	—	2	2	—	1	—	8	4,82
	Nubiens	1	—	—	1	—	—	—	2	—	—	2	1,20
(ABC)-BC.	Kamito-nilotiques	—	—	2	—	—	—	—	—	—	—	2	1,20
	Total...	20	6	20	20	20	20	12	20	20	8	166	

2. *Eléments autochtones africains sans caractères négroïdes.* On doit classer ici les 27 sujets du groupe ABC, et les 16 sujets du sous-groupe africain du groupe AC, soit au total 43 sujets représentant 25,9% de la population.

3. *Eléments autochtones africains présentant des caractères subnégroïdes.* On doit classer ici les 28 sujets du groupe AB et les 12 sujets du groupe BC — ces derniers incluant les 2 sujets du sous-groupe (ABC)BC —, soit au total 40 sujets représentant 24,1% de la population.

4. *Eléments présentant des affinités cananéennes.* Il y a lieu de faire une distinction entre les sujets du sous-groupe asiatique du groupe AC, au nombre de 25, soit 15,05% de la population, qui sont d'affinité strictement cananéenne, et les sujets du sous-groupe (ABC)-AC, au nombre de 27, soit 16,28% de la population, dont les éléments sont bien représentés en Canaan, notamment parmi les populations bédouines, mais qui en fait, ont des affinités sub-anatoliennes, leur zone originelle occupant une bande de territoires s'étendant de la côte méridionale d'Anatolie jusqu'aux confins irano-indiens.

Enfin, indépendamment des affinités typologiques, il y a lieu de considérer les classes d'indice céphalique ; on note :

Dolichocéphales, 87 sujets, soit 52,4% de la population ;
Mésocéphales, 73 sujets, soit 44% de la population ;
Brachycéphales, 6 sujets, soit 3,6% de la population.

On voit, d'après la faible proportion de ces derniers, que l'influence continentale est à peu près nulle ; les tribus installées à proximité de la côte occidentale de Cyrénaïque, ne comportent pratiquement que des éléments bien adaptés aux conditions écologiques d'une zone littorale, qu'ils soient autochtones au sens strict du terme, ou seulement établis dans la région depuis un certain nombre de générations.

Tribus de la côte septentrionale

Le détail de la distribution des types dans chaque tribu est donné au tableau II.

En considérant les groupes dans leur ensemble, on voit que sur les 189 sujets étudiés, le groupe AC prédomine avec 63 sujets représentant

TABLEAU II — TRIBUS DE LA CÔTE SEPTENTRIONALE DE CYRÉNAÏQUE

Groupes et types structuraux		Bengazi (Koroglia et Djaber)	Orfa			Dorsa				Hasa				Total	
			Salatna	Tasc	♀	Abd-el-Djawed	Mohammed	Baraqla	♀	Shabarqa	Bakhaïts	Qalabta	♀		
ABC,															
Paléo-kamitiques	dolichocéphales	—	4	2	1	6	5	1	—	1	7	2	1	30	15,85 %
	mésocéphales	—	—	2	—	3	2	2	—	4	1	3	1	18	9,52
	brachycéphale	—	—	—	—	1	—	—	—	—	—	—	—	1	0,52
AC, africains :	Kamitiques	—	1	—	—	2	1	2	—	2	—	1	—	9	4,76
	Libyco-berbères	—	—	4	—	2	1	1	2	—	—	—	1	11	5,83
	Berbéro-tellien	1	1	—	—	—	—	—	—	1	—	—	—	3	1,58
AC, asiatiques.	Sud-orientaux	1	1	—	—	—	1	1	—	2	2	1	—	9	4,76
	Syro-cananéens	—	4	—	—	—	—	2	—	1	1	2	—	10	5,29
(ABC)-AC.	Nord-syriens	1	4	—	—	1	—	1	1	—	1	2	—	11	5,82
	Ciliciens	1	—	4	—	—	—	1	1	2	—	1	—	10	5,29
A.	Méditerranéens anciens	—	—	1	—	—	3	3	2	5	3	4	—	21	11,11
	Alpino-méditerranéens	1	2	5	2	1	2	3	1	1	2	1	4	25	13,22
AB.	Nord-sahariens	—	—	1	1	2	1	—	—	—	1	—	1	7	3,71
	Sahariens	—	2	—	—	—	2	1	—	1	—	2	—	8	4,23
	Saharien des Oasis	—	—	—	1	—	—	—	—	—	—	—	—	1	0,52
BC.	Nord-nilotiques	—	1	1	1	1	2	—	—	1	—	—	—	7	3,71
	Nubiens	—	—	—	—	1	—	1	—	—	1	—	—	3	1,58
(ABC)-BC.	Kamito-nilotiques	—	—	—	—	—	—	1	—	—	—	1	—	2	1,05
	Kamito-nubiens	—	1	—	—	—	—	—	—	—	1	1	—	3	1,58
	Total	5	21	20	6	20	20	20	7	21	20	21	8	189	

33,33% de la population : il convient de distinguer, 23 sujets d'affinité africaine (12,18%), 19 sujets d'affinité cananéenne (10,05%), et 21 sujets d'affinité sub-anatolienne (11,11%). Le groupe ABC comporte 49 sujets représentant 25,9% de la population ; le groupe A a une importance à peine moindre, avec 46 sujets représentant 24,32% de la population. Les autres éléments ont un taux nettement plus faible : le groupe AB, avec 16 sujets, ne représente que 8,46% de la population, et le groupe BC, avec 15 sujets, 7,93% seulement.

En sélectionnant les sujets d'après leurs affinités géographiques, on peut distinguer :

1. *Eléments strictement méditerranéens.* Les sujets du groupe A, au nombre de 46, représentent 24, 32% de la population.

2. *Eléments autochtones africains sans caractères négroïdes.* On doit classer ici les 49 sujets du groupe ABC et les 23 sujets du sous-groupe africain du groupe AC, soit au total 72 sujets représentant 37,9% de la population.

3. *Eléments autochtones africains présentant des caractères sub-négroïdes.* On doit classer ici les 16 sujets du groupe AB et les 15 sujets du groupe BC — ces derniers incluant les 5 sujets du sous-groupe (ABC)-BC —, soit au total 31 sujets représentant 16, 39% de la population.

4. *Eléments présentant des affinités cananéennes.* On doit classer ici 40 sujets parmi lesquels il faut distinguer, 19 sujets du sous-groupe asiatique du groupe AC, d'affinité strictement cananéenne, représentant 10,05% de la population, et 21 sujets du sous-groupe (ABC)-AC, d'affinité sub-anatolienne, représentant 11,11% de la population.

L'examen de la distribution de l'indice céphalique nous donne des résultats concordant avec ceux obtenus pour la population de la côte occidentale :

Dolichocéphales, 96 sujets, soit 50,8% de la population ;
Mésocéphales, 88 sujets, soit 46,6% de la population ;
Brachycéphales, 5 sujets, soit 2,6% de la population.

Tribus de la zone sublittorale

Ces tribus sont établies à la limite de la zone désertique, à de faibles distances des côtés occidentale et septentrionale. Nous ne pouvons donc pas présumer trouver dans la composition de la population de cette zone, des caractères qui lui donneraient un aspect très différent de celle de la zone côtière.

Le détail de la distribution des types dans chaque tribu est donné au tableau III.

En considérant les groupes dans leur ensemble, on voit que, sur 274 sujets étudiés, le groupe AC prédomine très largement, avec 102 sujets représentant 37,2% de la population de cette zone sublittorale : il convient de distinguer 17 sujets d'affinité africaine (6,2%), 34 sujets d'affinité cananéenne (12,4%), et 53 sujets d'affinité sub-anatolienne (19,35%). Le groupe A se place ensuite, avec 56 sujets représentant 20,42% de la population ; puis le groupe AB, avec 45 sujets représentant 16,81% de la population, suivi du groupe ABC, avec 36 sujets représentant 13,13% de la population ; vient enfin le groupe BC, avec 33 sujets représentant 12,05% de la population.

En regroupant les types d'après leurs affinités géographiques, on arrive à la sélection suivante :

1. *Eléments strictement méditerranéens.* Ce sont les 56 sujets du groupe A, représentant 20,42% de la population.

2. *Eléments autochtones africains sans caractères négroïdes.* On doit classer ici les 36 sujets du groupe ABC et les 17 sujets du sous-groupe africain du groupe AC, soit au total, 53 sujets représentant 19,35% de la population.

3. *Eléments autochtones africains présentant des caractères sub-négroïdes.* On doit classer ici les 45 sujets du groupe AB, et les 33

TABLEAU III — Tribus de la Zone Sublittorale de Cyrénaïque

Groupes et types structuraux		Zweyia	Bra'asa					Fayed	Awadjila	Madjabra	Aqayil	Twadjir ♂	Abeidat						Total	
			Tamia	Masayed	Husein	Ouled-Hamid	♀						Qeïts	Ber Imama	Meriem	War	Ouled Benina	♀		
ABC, Paléo-kamitiques	dolichocéphales ...	—	1	4	1	4	—	1	3	—	—	—	4	1	—	1	5	—	25	9,12 %
	mésocéphales	—	—	—	2	—	1	—	—	—	—	—	—	3	—	2	3	—	11	4,01
AC, africains.	Kamitiques	1	—	—	1	—	—	—	—	—	1	1	1	—	—	—	—	—	5	1,82
	Libyco-berbères	—	1	2	4	1	—	—	—	—	—	—	2	1	1	—	—	—	12	4,38
AC, asiatiques.	Sud-orientaux	3	2	—	1	1	—	—	1	3	1	—	1	1	1	1	1	—	17	6,2
	Syro-cananéens	2	1	1	1	—	—	1	—	2	1	—	2	1	1	2	1	—	16	5,84
	Syro-arménoïde......	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	0,36
(ABC)-AC.	Nord-syriens	3	4	3	3	4	—	—	7	6	—	—	1	1	4	6	2	1	45	16,41
	Ciliciens	—	1	—	—	2	—	—	—	—	—	—	—	1	1	3	—	—	8	2,86
A.	Méditerranéens anciens	3	3	4	2	2	1	—	—	—	1	—	2	2	4	—	3	2	29	10,58
	Alpino-méditerranéens	—	2	1	2	2	5	—	—	—	—	—	3	1	3	—	1	5	25	9,12
	Alpinoïdes	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	2	0,73
AB.	Nord-sahariens	3	1	2	—	1	—	—	2	5	—	—	1	2	—	—	—	—	17	6,2
	Sahariens	3	4	3	—	1	3	—	2	1	—	—	1	2	2	2	2	—	26	9,49
	Sahariens des Oasis. .	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	2	0,73
BC.	Nord-nilotiques	2	1	1	2	—	1	—	1	1	1	—	2	3	2	—	1	—	18	6,56
	Nubiens	—	—	—	—	1	—	—	—	—	—	—	—	—	2	1	1	—	5	1,82
(ABC)-BC.	Kamito-nilotiques	—	—	—	1	1	—	—	4	1	—	—	—	1	—	1	—	—	9	3,28
	Kamito-nubien	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	0,36
	Total ...	20	21	22	20	20	12	2	20	19	5	3	20	20	21	19	20	10	274	

sujets du groupe BC — ces derniers incluant les 10 sujets du sous-groupe (ABC)-BC—, soit au total 78 sujets représentant 28,45% de la population.

4. *Eléments présentant des affinités cananéennes.* On doit grouper ici 87 sujets parmi lesquels il y a lieu de distinguer, 34 sujets du sous-groupe asiatique du groupe AC, d'affinité strictement cananéenne, représentant 12,4% de la population, et 53 sujets du sous-groupe (ABC)-AC, d'affinité sub-anatolienne, représentant 19,35% de la population.

L'examen de la distribution de l'indice céphalique, donne des résultats concordant avec ceux des régions voisines :

Dolichocéphales, 165 sujets, soit 60,2% de la population ;
Mésocéphales, 104 sujets, soit 38% de la population ;
Brachycéphales, 5 sujets, soit 1,8% de la population.

Tribus de la côte orientale

Ces tribus sont établies dans une zone côtière, contiguë aux précédentes, mais situées plus à l'est, et leur territoire s'étend jusqu'à la frontière égyptienne.

Le détail de la distribution des types dans chaque tribu est donné au tableau IV.

En considérant les groupes structuraux dans leur ensemble, on note que, sur 195 sujets étudiés, le groupe AC prédomine, avec 75 sujets représentant 38,48% de la population de la côte orientale de Cyrénaïque : à l'intérieur de cette entité, il convient de distinguer, 21 sujets d'affinité africaine (10,78%), 21 sujets d'affinité cananéenne (10,78%), et 33 sujets d'affinité sub-anatolienne (16,92%). Le groupe A est également très important, avec 49 sujets représentant 25,19% de la population ; le volume des autres groupes est nettement plus faible : le groupe AB, avec 30 sujets, représente 15,39% de la population ; le groupe ABC, avec 22 sujets, 11,28%, et enfin le groupe BC, avec 19 sujets, seulement 9,74% de la population.

TABLEAU IV — TRIBUS DE LA CÔTE ORIENTALE DE CYRÉNAÏQUE

Groupes et types structuraux		Mwalek	Shiheyibat	Houta	Shwayir	Taraki	Swana	Qeta'an		Mnefa		Divers		Total	
								Rahamma	Mrerat	Mseka	Aloun	♂	♀		
ABC,															
Paléo-kamitiques	dolichocéphales	—	2	4	3	1	1	1	2	—	—	1	—	15	7,69 %
	mésocéphales	—	—	3	—	1	—	1	—	1	—	1	—	7	3,59
AC, africains.	Kamitiques	—	—	1	2	4	—	—	—	—	—	1	—	8	4,11
	Libyco-berbères	1	—	—	1	3	—	1	1	2	—	2	2	13	6,66
AC, asiatiques.	Sud-oriental	—	3	2	—	—	—	2	3	1	—	1	—	12	6,16
	Syro-cananéen	1	1	1	—	—	—	—	1	2	1	1	—	8	4,11
	Syro-arménoïde	—	—	—	—	—	1	—	—	—	—	—	—	1	0,51
(ABC)-AC.	Nord-syrien	2	1	2	3	1	3	—	2	3	5	—	—	22	11,28
	Cilicien	1	—	—	1	—	1	4	—	2	1	1	—	11	5,64
A.	Méditerranéens anciens	—	—	1	7	4	3	2	3	2	3	2	1	28	14,36
	Alpino-méditerranéens	—	1	6	—	1	—	3	4	3	1	—	2	21	10,78
AB.	Nord-sahariens	1	1	1	2	—	1	2	—	2	4	—	—	14	7,18
	Sahariens	—	—	3	1	1	—	2	1	1	4	1	2	16	8,2
BC.	Nord-nilotiques	—	—	—	—	1	—	2	1	1	—	2	—	7	3,59
	Nubiens	—	—	—	1	2	—	—	1	—	—	1	2	7	3,59
(ABC)-BC.	Kamito-nilotiques	—	1	—	—	2	—	—	1	—	1	—	—	5	2,56
	Total ...	6	10	24	21	21	10	20	20	20	20	14	9	195	

En regroupant les sujets d'après leurs affinités géographiques, on arrive à la sélection suivante :

1. *Eléments strictement méditerranéens.* Ce sont les 49 sujets du groupe A, représentant 25,19% de la population.

2. *Eléments autochtones africains sans caractères négroïdes.* On doit classer ici les 22 sujets du groupe ABC et les 21 sujets du sous-groupe africain du groupe AC, soit au total 43 sujets représentant 22,06% de la population.

3. *Eléments autochtones africains présentant des caractères sub-négroïdes.* Il convient de classer ici les 30 sujets du groupe AB et les 19 sujets du groupe BC — ces derniers incluant les 5 sujets du sous-groupe (ABC)-BC —, soit au total 49 sujets représentant 25,13% de la population.

4. *Eléments présentant des affinités cananéennes.* On doit grouper ici 44 sujets parmi lesquels il y a lieu de distinguer 21 sujets du sous-groupe asiatique du groupe AC, d'affinité strictement cananéenne, représentant 10,78% de la population, et 33 sujets du sous-groupe (ABC)-AC, d'affinité sub-anatolienne, représentant 16,92% de la population.

L'examen de la distribution de l'indice céphalique, donne ici encore, des renseignements concordant avec ceux des autres régions de cette partie septentrionale de la Cyrénaïque :

Dolichocéphales, 111 sujets, soit 56,9% de la population ;
Mésocéphales, 83 sujets, soit 42,6% de la population ;
Brachycéphales, 1 seul sujet, soit 0,5% de la population.

Conclusions sur le peuplement de la partie septentrionale de la Cyrénaïque

Les populations des différentes régions considérées jusqu'ici, présentent de telles similitudes, qu'il convient de regrouper en une seule série les 824 sujets étudiés dans la partie de la Cyrénaïque située au nord du désert libyque.

L'ensemble de la documentation est donné au tableau V :

On voit que le groupe AC prédomine partout, représentant les 37,34% de l'ensemble de la population; toutefois, contrairement à ce que l'on pourrait attendre étant donnée la localisation géographique, au sein de cette entité c'est le sous-groupe (ABC)-AC qui est le plus nombreux (16,25%) surpassant nettement le sous-groupe africain (9,34%) et même le sous-groupe asiatique (12%). Le groupe A est lui-aussi bien représenté, comptant pour 21,83% de la population; le groupe ABC est un peu moins important, son taux étant de 16,25%. Les autres groupes sont sensiblement plus faibles : le groupe AB ne compte que pour 14,42%, et le groupe BC pour 9,58% seulement.

Si l'on regroupe les sujets d'après leurs affinités géographiques, on peut reconnaître les éléments suivants :

1. *Eléments strictement méditerranéens.* Ce sont les 180 sujets du groupe A, représentant 21,83% de la population de la Cyrénaïque septentrionale.

2. *Eléments autochtones africains sans caractères négroïdes.* On doit réunir ici les 134 sujets du groupe ABC et les 77 sujets du sous-groupe africain du groupe AC, soit au total 211 sujets représentant 25,59% de la population.

3. *Eléments autochtones africains présentant des caractères sub-négroïdes.* Il convient de classer ici les 119 sujets du groupe AB et les 79 sujets du groupe BC — ces derniers incluant les 22 sujets du sous-groupe (ABC)-BC —, soit au total 198 sujets représentant 24% de la population.

4. *Eléments présentant des affinités cananéennes.* On doit grouper ici 233 sujets parmi lesquels il convient de distinguer, 99 sujets du sous-groupe asiatique du groupe AC, d'affinité strictement cananéenne, représentant 12% de la population, et 134 sujets du sous-groupe (ABC)-AC, d'affinité sub-anatolienne, représentant 16,25% de la population. La proportion importante de ces derniers, au sein de populations rurales, ne comprenant que des sujets d'origine indigène, au sens étymologique du terme, est un caractère remarquable qui sera

TABLEAU V — PEUPLEMENT DE LA CYRÉNAÏQUE SEPTENTRIONALE

	Côte occidentale		Côte septentrionale		Zone sublittorale		Côte orientale		Total	
		%		%		%		%		%
Groupe ABC	27	16,26	49	25,90	36	13,13	22	11,28	134	16,25
Groupe AC	68	41,0	63	33,33	102	37,20	75	38,48	308	37,34
dont sous-groupe africain	16	9,64	23	12,18	17	6,20	21	10,78	77	9,34
asiatique	25	15,05	19	10,05	34	12,40	21	10,78	99	12,0
sub-anatolien	27	16,26	21	11,11	53	19,35	33	16,92	134	16,25
Groupe A	29	17,49	46	24,32	56	20,42	49	25,13	180	21,83
Groupe AB	28	16,88	16	8,46	45	16,81	30	15,39	119	14,42
Groupe BC	10	6,02	10	5,29	23	8,38	14	7,18	57	6,91
Sous-groupe (ABC)-BC	2	1,20	5	2,64	10	3,65	5	2,56	22	2,67
Total ...	166		189		274		195		824	

considéré avec la plus grande attention, lorsque nous étudierons la question de l'origine des différents éléments composant la population de Cyrénaïque.

L'examen de la distribution de l'indice céphalique donne :

Dolichocéphales, 459 sujets, soit 55,7% de la population ;
Mésocéphales, 348 sujets, soit 42,2% de la population ;
Brachycéphales, 17 sujets, soit 2,1% de la population.

Le taux très élevé des dolichocéphales et la très faible proportion des brachycéphales, sont des indices très sûrs pour caractériser une population adaptée à l'écologie d'une région proche de la mer.

Tribus du sud de la Cyrénaïque

Ces tribus sont établies dans les oasis situées dans la région de Koufra, au sud du désert libyque, non loin de la frontière égyptienne.

Le détail de la distribution des types dans chaque tribu est donné au tableau VI.

En considérant les groupes structuraux dans leur ensemble, on note que sur 99 sujets étudiés, le groupe AB prédomine, avec 34 sujets représentant 35,38% de la population ; vient ensuite le groupe B qui, avec 33 sujets, compte pour 33,3% de la population ; le groupe BC, avec 22 sujets, représente 22,23%, et enfin le groupe ABC, avec 9 sujets, 9,09% seulement.

A cette simple énumération, il apparaît que la composition de la population des oasis du sud, est tout-à-fait différente de celle de la partie septentrionale de la Cyrénaïque. Ces différences seront encore plus évidentes en regroupant les sujets d'après leurs affinités géographiques.

1. *Eléments strictement méditerranéens.* Il n'y a aucun sujet à classer dans le groupe A ; aucun élément méditerranéen cromagnoïde ne participe donc à la composition de la population des oasis.

2. *Eléments autochtones africains sans caractères négroïdes.* Ceux-ci ne sont représentés que par les 9 sujets du groupe ABC comptant à peine pour 9,09% de la population.

TABLEAU VI — TRIBUS DU SUD DE LA CYRÉNAÏQUE

Groupes et types structuraux		For	Rashid	Waday	Dadjou	Salamat	Banda	Baqirmi	Sara	Bornou	Divers ♂	Total	
ABC, Paléo-kamitiques	dolichocéphales	1	1	—	1	1	—	1	—	—	2	7	7,07 %
	mésocéphales	—	—	—	—	—	—	1	—	1	—	2	2,02
AB.	Nord-sahariens	4	3	2	3	—	2	1	2	3	1	21	21,2
	Sahariens	1	—	3	—	1	3	1	—	1	1	11	11,11
	Sahariens des oasis	—	—	—	—	—	2	—	1	—	—	3	3,03
BC.	Nord-nilotiques	—	—	—	—	—	—	—	2	—	1	3	3,03
	Nubiens	—	—	1	—	—	—	1	—	—	—	2	2,02
	Nubien des oasis	—	—	—	—	—	—	—	1	—	—	1	1,01
(ABC)-BC.	Kamito-nilotiques	3	2	2	2	1	—	2	—	1	—	13	13,12
	Kamito-nubiens	—	—	—	—	1	—	—	—	1	—	2	2,02
	Kamito-nubien des oasis	—	—	—	—	—	—	—	1	—	—	1	1,01
B.	Soudanais	1	4	2	2	1	1	2	—	1	1	15	15,14
	Soudano-sahariens	—	—	—	—	—	1	—	2	1	—	4	4,04
(ABC)-B.	Kamito-soudanais	—	—	—	2	1	1	2	—	1	2	9	9,09
	Kamito-sahariens	—	—	—	—	4	—	—	1	—	—	5	5,05
	Total ...	10	10	10	10	10	10	11	10	10	8	99	

3. *Eléments autochtones africains présentant des caractères subnégroïdes.* C'est la communauté la plus importante, qui avec les 34 sujets du groupe AB, et les 22 sujets du groupe BC — ces derniers incluant 16 sujets du sous-groupe (ABC)-BC —, comprend au total 56 sujets comptant pour 57,61% de la population.

4. *Eléments présentant des affinités cananéennes.* Il n'y a aucun sujet se classant dans le groupe AC ; de ce fait, il n'y a aucun sujet présentant des affinités cananéennes.

5. *Eléments négroïdes.* Avec 33 sujets du groupe B, dont 14 du sous-groupe (ABC)-B, 33,3%, soit un tiers de la population des oasis, présentent des affinités soudanaises.

Il apparaît donc clairement que, si la Cyrénaïque septentrionale est largement ouverte sur la Méditerranée et le monde arabe, les oasis du sud sont au contraire entièrement tournées vers l'Afrique noire.

L'examen de la distribution de l'indice céphalique indique :

Dolichocéphales, 68 sujets, soit 68,7% de la population ;
Mésocéphales, 26 sujets, soit 26,3% de la population ;
Bracycéphales, 5 sujets, soit 5 % de la population.

Comme chez les populations mélanodermes, les dolichocéphales prédominent très nettement, sans que cela implique une influence maritime.

ORIGINES DES DIFFÉRENTS ÉLÉMENTS DE LA POPULATION

Pour essayer de déceler les origines de chaque élément reconnu en Cyrénaïque, nous devons comparer les populations que nous venons d'analyser aux populations voisines.

Dans notre étude sur les populations du district occidental d'Egypte, nous avons montré qu'il y avait à **Siwah**, à côté du noyau africain autochtone (26,35%), un important élément africain présentant des caractères négroïdes plus ou moins accusés [1] : parmi ceux-ci, on peut

[1] *Op. cit.*, 1962, p. 59.

distinguer des sub-négroïdes (29%) et des vrais négroïdes (3,9%) ; mais en dehors de ces éléments africains, il y avait aussi des éléments méditerranéens (6,58%) et des éléments cananéens (28,96%), ce qui surtout pour ces derniers, représente des taux non négligeables, alors que ces éléments font entièrement défaut dans les oasis du sud de la Cyrénaïque.

A l'ouest de cette zone des oasis se trouve le **Fezzan**, où une enquête anthropologique [1] a été faite en 1944. Celle-ci, malheureusement non exhaustive, donne de précieuses indications sur la composition de la population ; grâce aux mensurations et aux descriptions publiées sur 33 sujets, nous avons pu déterminer la structure typologique de ces derniers avec une grande précision.

Groupe AC : type kamitique (AC_1) : arabe fezzanais n° 11 ;
type nord-syrien (ABC)-AC_1 : arabe fezzanais n° 4.

Groupe A : type méditerranéen ancien (A_1) : touareg adjer n° 2, 4, 5, 8 ; berbère fezzanais n° 3 ;
type alpino-méditerranéen (A_2) : targhi adjer n° 3.

Groupe BC : type nord-nilotique (BC_1) : targhi adjer n° 7 ;
arabe fezzanais n° 2 ;
berbère fezzanais n° 5.

Hybrides : Méditerranéen ancien et Kamitique ($A_1 \times AC_1$) :
arabe fezzanais n° 1 ;
Méditerranéen ancien et Nord-syrien ($A_1 \times$ (ABC)-AC_1) : berbère fezzanais n° 7 ;
Méditerranéen ancien et Nord-Saharien ($A_1 \times AB_1$) :
targhi adjer n° 6 ; tebou n° 1, 5 ;
arabes fezzanais n° 3, 5, 7, 9, 10 ;
berbères fezzanais n° 1, 2.
Alpino-méditerranéen et Saharien ($A_2 \times AB_2$) :
tebou n° 2, 4 ; arabe fezzanais n° 8 ;
berbère fezzanais n° 4.

[1] M.E. Leblanc, Mission scientifique du Fezzan : I. Anthropologie et Ethnologie, 45 p., tabl., Paris, 1945.

Alpinoïde et Saharien des Oasis ($A_3 \times AB_3$) :
arabe fezzanais n° 5.
Méditerranéen ancien et Nord-Nilotique ($A_1 \times BC_1$) :
targhi adjet n° 1 ; tebou n° 3, 6 ;
berbère fezzanais n° 8.
Méditerranéen ancien et Soudanais ($A_1 \times B_1$) :
berbère fezzanais n° 6.

Cette distribution donne pour les groupes les proportions suivantes :

Groupe A	40,7 %
Groupe AB	27,8 %
Groupe BC	18,5 %
Groupe AC	5,6 %
Sous-groupe (ABC)-AC	5,6 %
Groupe B	1,9 %

En considérant les affinités géographiques de chaque groupe, on peut reconnaître :

1. *Eléments strictement méditerranéens* (groupe A) : 40,7%.

2. *Eléments autochtones africains sans caractères négroïdes* (ici uniquement groupe AC) : 5,8%.

3. *Eléments autochtones africains présentant des caractères sub-négroïdes* (groupes AB et BC) : 46,3%.

4. *Eléments présentant des affinités cananéennes*; ici, uniquement affinité sub-anatolienne (sous-groupe (ABC)-AC) : 5,6%.

5. *Eléments négroïdes* (groupe B) : 1,9%.

On voit que les vrais négroïdes sont plus nombreux autour de Koufra qu'à Siwah, où l'on en compte cependant plus que dans le Fezzan; en revanche, si les sub-négroïdes sont plus nombreux autour de Koufra que dans le Fezzan, ils sont ici beaucoup plus nombreux qu'à Siwah.
L'élément africain autochtone non négroïde était important à Siwah, il est très faible autour de Koufra et dans le Fezzan.

L'élément cananéen, témoignage de l'influence arabe, est sensible à Siwah comme dans le Fezzan; absent autour de Koufra.
L'élément méditerranéen, faible à Siwah, absent à Koufra, est important dans le Fezzan.
Sergio Sergi qui a étudié des restes anciens provenant de Jerma, attribue aux Garamantes cet élément méditerranéen [1]. C'est peut-être aller un peu vite dans les conclusions, et ce point de vue a été critiqué par Leblanc. Tout ce que l'on peut dire, c'est que tout se passe comme si à un fond autochtone sub-négroïde, se surajoutaient :

— dans la zone méditerranéenne, un élément cananéen introduit depuis l'Antiquité par les Bédouins, et plus récemment par les Arabes;

— dans le Fezzan, un élément méditerranéen introduit depuis la Tripolitaine en direction du sud;

— dans la région de Koufra, et de là vers Siwah, un élément négroïde, témoignage d'une poussée des populations de l'Afrique noire en direction de la Méditerranée.

La région de Koufra semble donc être un jalon sur la route des populations soudanaises parvenues jusqu'à Siwah.
Un autre élément étranger important est l'élément sub-anatolien. Le sous-groupe (ABC)-AC est absent à Koufra, faible dans le Fezzan; il est en revanche sensible à Siwah et dans la Cyrénaïque du nord. Dans notre étude sur les populations du district occidental d'Egypte, nous avons émis l'hypothèse que sa présence à Siwah était le témoignage de l'établissement d'éléments caravaniers, venus de Syrie et de Canaan à toutes les époques [2]; ceci reste vrai pour la Cyrénaïque, mais toutefois ne permet pas d'expliquer comment en certains points de la Cyrénaïque, l'élément sub-anatolien est plus important qu'à Siwah, alors que l'on s'attendrait à ce que le taux de cet élément soit plus faible au fur et à mesure que l'on progresse vers l'Ouest.

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[1] Sergio Sergi, Le reliquie dei Garamanti, *Boll. della R. Soc. Geogr. Ital.*, Rome, 1936.
[2] *Op. cit.*, 1962, p. 65.

Par ailleurs, le groupe A, strictement méditerranéen, dès le Néolithique ne compte plus que pour 19,5% de la population du Maghreb, et pour 10 à 13% en Egypte [1]; son taux varie de 6,58 à 13,8% en Egypte occidentale [2]. On ne peut expliquer son taux plus élevé en Cyrénaïque (de 16,88 à 25,19%) et au Fezzan (jusqu'à 40%), que par une arrivée sur la côte cyrénéenne de populations venant d'une autre rive de la Méditerranée.

Nous savons qu'aux anciens Libyens, s'ajoutèrent au XIIIe siècle avant Jésus-Christ, d'importants groupement anatoliens, connus par les textes égyptiens sous le nom de *Mašawaš*, et par les textes hittites sous le nom de *Maša*. M. B. Sakellariou [3] a montré que le pays *Maša* était mentionné, constamment en rapport avec *Mira, Kuvalija, Arzava,* et *Karkiša*. On peut donc raisonnablement admettre que le pays *Maša* devait se trouver sur la côte anatolienne, immédiatement à l'ouest de la Cilicie. Nous savons par des enquêtes récentes [4] que depuis la plus haute antiquité, les groupes A et AC (plus spécialement le sous-groupe (ABC)-AC) prédominent au sein de la population dans cette partie de l'Anatolie; il devient alors évident que le taux élevé des éléments A et (ABC)-AC en Libye, est le témoignage de l'arrivée des *Mašawaš* dans ce pays. On reconnaît du reste très bien ce « type ionien» sur le sujet d'une tribu Mnefa reproduit par Puccioni (in Biasutti, *op. cit.*, 1955, p. 120, fig. 86 en haut) qui avait lui-même remarqué que ce sujet présentait un aspect plus européen qu'africain : on peut voir des sujets semblables sur toute la côte méridionale de l'Anatolie, ainsi qu'en Chypre au sein de la communauté dite turco-chypriote, qui, en fait, est constituée par des Ioniens musulmans, venus de la côte anatolienne toute proche, et non par des vrais Turcs, qui se classent dans les groupes (ABC)-C et BC, et sont originaires de l'Asie Centrale.

[1] Robert-P. Charles, Recherches sur l'unité de structure et d'origine du peuplement de l'Afrique méditerranéenne, *Bull. Soc. Géogr. d'Egypte,* t. XXXVI, 1963, spécialement pp. 80-83.

[2] *Op. cit.,* 1962, p. 66.

[3] Michel B. Sakellariou, La migration grecque en Ionie, Athènes, 1958, p. 452.

[4] Robert-P. Charles, Le peuplement de Chypre dans l'Antiquité, *Etud. Chypriotes II,* Paris, 1962; Anthropologie archéologique de la Crète, *Etud. Crétoises XIV,* Paris, 1965, *passim.*

Dans la partie occidentale de l'Egypte, l'importance moyenne du groupe A est de 14,5%, et celle du sous-groupe (ABC)-AC est de 10%; en Cyrénaïque, on trouve respectivement 21,6 et 16,5% pour ces éléments. On peut donc, semble-t-il, admettre que la différence, soit 6,9% de sujets du groupe A et 6,5% de sujets du sous-groupe (ABC)-AC, représente le volume de la communauté issue des antiques *Mašawaš* (au total 13,4% de la population de la Cyrénaïque septentrionale).

CONCLUSIONS

La méthode typologique de Falkenburger, appliquée aux populations modernes de Cyrénaïque, comme nous l'avions déjà appliquée à certaines populations modernes d'Egypte, nous a permis de reconnaître :

— un élément autochtone sub-méditerranéen représentant 25,85% de la population du nord de la Cyrénaïque, 9,09% seulement de celle du sud;

— un élément autochtone sub-négroïde représentant 23,67% de la population du nord, et 57,61% de celle du sud;

— un élément négroïde, non représenté dans le nord, mais constituant le tiers de la population du sud;

— un élément cananéen — disons arabe pour une meilleure compréhension — représentant 22,13% de la population du nord, mais non représenté au sud;

— un élément méditerranéen autochtone, représentant 14,5% de la population du nord, et non représenté au sud;

— un élément originaire d'Anatolie, mais installé dans le pays depuis la fin de l'âge du Bronze, représentant 13,4% de la population du nord, et non représenté au sud.

Nous avons également pu mettre en évidence que la région de Koufra était, comme celle de Siwah en Egypte, un jalon sur la route suivie par

les peuples en mouvement depuis l'Afrique noire jusqu'au monde méditerranéen, tandis que la poussée des peuples méditerranéens vers le Sahara s'était exercée plus à l'Ouest, depuis les Syrtes jusqu'au Fezzan.

Ainsi les méthodes de l'Anthropologie archéologique, appliquées aux populations modernes, permettent-elles de déceler et d'apprécier les modifications introduites par les invasions survenues au cours des siècles, amenant des couches humaines nouvelles, qui se sont superposées au vieux fond autochtone, sans jamais le faire disparaître.

THE FACE OF THE MOSLEM WORLD

BY

A. A. KAMEL

I. — THE CHANGING BORDERS.

The borders of the Moslem World have been liable to continuous changes which cannot be completely controlled in favour of, or against Islam. Two main forces interact to reshape these borders :

1. The first force is the missionary nature of Islam. It does not confine itself to the realm of ideas. It is an integrated whole of concepts and of social, political, legislative patterns. There are no priests in Islam. Its adherents consider themselves preachers. From the very beginning, it has been able to overcome great obstacles that still face many non-Moslem communities. It has rejected racial prejudice, caste discrimination, colour bar, bitter fanaticism, and accepted fraternity and equality [1]. In a few decades, this spirit carried Islam far beyond its birth-place in Mecca and its base in Medina, and spread it over vast areas in Asia, Africa and Europe.

2. Other forces have worked against Islam, trying to push back its borders, and regain some of the grounds that Islam had already scored. From Europe burst furious troops which were misled by false information to subdue the Moslem World. The Crusades had a strong hold on the European World when Europe was discovering its entity long after the fall of the Roman Empire. The enthusiasm that was created by the first invasion succeeded—for the first time—in binding together the scattered European states, tribes and classes. During the Crusades,

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[1] *The Holy Quran,* 49 : 11-13, See also : Rida, M.R., Al Waḥy Al Moḥammadi, (*The Mohammedan Revelation*) et passim, Manar Press, Cairo, 1935. This is one of the best Arabic textbooks that discuss the spirit of Islam and its universal nature.

religion became the supreme bond in Europe. It was natural for the papacy to take the lead in the initiating of a Crusade, since the object was (at least ostensibly) religious; thus the power of the popes was increased by the war propagande and by the religious zeal that was excited [1].

To maintain its continuity this experiment had to evolve a distorted concept of Islam : a concept which poisoned the western mind through its intentional misinterpretation of Islamic ideals. There are some traces of the old crusading spirit on the western mind.

However, there is a new moderate and even amicable trend of thought towards Islamic culture in Europe. It is still confined to academic circles and has not yet gained the official and popular recognition which may aid it to become the prevailing wind which blows from the west towards the Moslem World [2].

These aggressive traces can be discerned in the plans of imperialists and missionaries. Colonization tried to hamper the march of Islam, especially in Africa. The Savanna Belt—south of the Sahara—has always been an important field for these campaigns. Late in the nineteenth century and in the early decades of the twentieh, the success of a mission in gaining new grounds and new followers, was quickly followed by economic enterprise and political dominance. For raw materials, new lands and markets, imperialists managed to utilise clergymen as spear-heads in the colonial field.

Besides these two fronts, i. e. : the European and African, the Asian front has been affected by the communist attitude towards religion. For, though the eastern block has its own materialistic idiology, it guarantees religious freedom; but it also-legally-forbids the preaching of religious thought [3].

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[1] Bertrand Russel, *A History of Western Philosophy,* p. 455, George Allen and Unwin, London 1948.

[2] See for example : Sigrid Hunke, *Allahs Sonne über dem Abenland, Deutsche Verlags-Anstalt,* Stuttgart, (1962) et passim. Translated into Arabic; by F. Hassanain, Arabic Renaissance Lib., Cairo, 1964.

[3] Article 124 of the Soviet constitution guarantees «freedom of religious worship». It also guarantees «freedom of antireligious propaganda».

II. — POPULATION : TWO POINTS OF VIEW.

1. The Western Point of View :

The question is : how many Moslems are there on our planet? And, where do they exist?

Many references try to answer these questions : *L'Annuaire du Monde Musulman* of L. Massignon, *Atlas of Islamic History* of H. W. Hazard. Some textbooks of political geography such as Fernau's, *Moslems on the March.*

All these references vary in their estimates. This can be attributed to the following factors :

1. Many of the so called underdeveloped or developing countries have no vital statistics.

2. The colonial powers were—and still are—reluctant to give accurate information about their colonies. They used to publish imaginative estimates about the natives.

3. Most of the modern states do not include religion in their census tables.

4. Where apostacy is officially adopted, religious freedom suffers in a way or another. Persons of religious beliefs —Moslems or non-Moslems— find themselves, even if not directly ordered, practically obliged to conceal their beliefs and rituals. Consequently, new generations are led astray from their traditionally religious atmosphere. They are confused by the conflict between inherited creeds and the new ideologies. In this case official census returns do not give us what the peoples' real religious beliefs are, but rather their guarded declaration concerning their faith in order to be on the right side of the official attitude. The expected result is an underestimation of religious believers as a whole and of Moslems in particular.

5. The same result is obtained through colonization. In the modern world, the colonial and neo-colonial powers are largely Europeans. They have inherited the crusading attitude towards Islam, especially in Africa, where the last and final battles of liberation are taking place.

In spite of these factors —or obstacles —Islam still gains new followers on some fronts, especially in Tropical Africa. It has doubled its followers in Africa within the last thirty years. Reports of missions of different churches state that Islam renders a great part of their efforts in Africa of no avail [1]. Many European administrators and statesmen maintain that the preaching of Islam is not that of a mere religious movement in the narrow sense. It has been attached to the political aims towards which Africans strive, especially in the case of Arab Nationalism movement. From the preaching point of view, Cairo has an important and active role in the whole Moslem World. Al-Azhar University, is the corner stone of these activities [2].

Having all these factors and their conclusions in mind, it is not surprising then to find wide differences among references that try to answer the aforesaid questions about Muslims : How many are they? Where do they live?

Western references in general estimate give the whole Moslem population of the world at less than 400 million (Table 1).

The range of variation will be wider if we refer to earlier estimates. At the turn of the twentieh century Zwemer (1907) estimated the whole Moslem population at 300 million [3], the same figure was accepted by Bethman for the mid-century [4] as if this population remained stagnant without any increase for about fifty years!

2. The Moslem's Point of View :

Some Moslem institutions tried to rectify these estimates on scientific and objective bases. One of them in Karachi (Pakistan), established by Bagum A. I. Bawany, published in January 1957, a booklet entitled

[1] Cross and Crescent in Africa, *The Islamic Review*, p. 24, March 1957, (Unsigned). This article is an excerpt taken from a leeflet published by Verona Fathers Missions, London, on the «happy occasion of the 80th birthday of His Holiness Pope Pious XII».

[2] Baulin, J., *The Arab Role in Africa*, pp. 17-18, Penguin African Lib., 1962.

[3] In : Masdoosi, A.A., Living Religions of the World, p. 27, *Begum Aisha Bawany Wakf*, Karachi, Translated from Urdu into English by Z.I. Ansari, 1962.

[4] *Ibid.*, p. 27.

TABLE 1

Moslem Population of the World : Western References

REFERENCE	YEAR	MOSLEM POPULATION OF THE WORLD (in millions)
Hazard [1]	1953	390
Massignon [2]	1954	368
Fernau [3]	1955	320-350
National Catholic Almanac [4]	1957	416.6

« Moslems in the World» [5]. This centre of research started its investigations in the year 1954. The aforesaid references were at hand. The centre contacted the concerned embassies and gathered about fifty eight reports for the years 1951-1954. The editor, A. A. Hashmi, travelled widely in the Middle East and South and East Asia. He considered and discussed the wide variety of the different published estimates and recognised the difficulties that faced the task. He states that he cannot assume that all the figures recorded in his report are completely accurate, but he believes that they are—at least—the nearest to reality. He estimates the whole Moslem population at 550 million.

In 1958 another book of the same trend was published by Begum. A Bawany Wakf in Karachi. It was the Urdu text of « *Mazaḥib 'Alam*», by A. A. Al Masdoosi. It was translated into English in 1962 by Z. I. Ansari. It gives the Moslem population a figure of 520.7 million [6].

[1] Hazard, H.W., *Atlas of Islamic History*, p. 5, Princeton Univ. Press, 1954 (1953 estimates).

[2] Massignon, L., *Annuaire du Monde Musulman*, 1954, p. 428, Presses Universitaires de France, Paris 1955.

[3] Fernau, F.W., *Moslems on the March*, p. 47, Robert Hale, London, 1955.

[4] In : Masdoosi, A.A., Living Religions of the World, p. 27, *Begum Aisha Bawany Wakf*, Karachi, Translated from Urdu into English by Z.I. Ansari, 1962.

[5] Hashmi, A.A., Muslems in the World, *Begum Aisha Bawany Educational Trust*, Karachi, 1957.

[6] *Op. cit.*, p. 70.

Masdoosi's study is more detailed and documented. It is rectified to 1951 as a base year for all his comparative study. They form 22% of the whole population of the world estimated at 2540 million for the year 1951. The annual rate of increase for the years 1950-1961 is 1.8% with a total population for the whole world of 3069 million in 1961. Accordingly, the Moslem population, if the same annual increase of the world be accepted for Moslems, can rise in 1961 to about 621.7 million. This is a rough figure, having in mind that the annual rate of increase in Asia and Africa, where the majority of Moslem population exists, is higher than the mean for the world as a whole [1].

III. — THE PHYSICAL LAYOUT.

Most of this population is disposed for the most part in and around a broad belt of country that covers a total area of about 37.5 million square kilometres [2]. Extends across Northern Africa from the Mediterranean to the savanna belt south of the Sahara, whence eastwards across Arabia and Turkey, Iran, Afghanistan, West Pakistan, the Moslem States in S.W. of the U. S. S. R., a belt of territory that practically encircles the Caspian and extends into Western and Central China, with important outliers in Malaysia, Indonesia, Philippines. There is a large block of Moslems in East Pakistan, a second in India and a third —but smaller— in S.E. China, and a band running down the eastern side of Africa to the region opposite Malagashe [3]. In addition, there are many minor tracts in Europe. The major part of the European Moslem population lies in the Balkans —especially in Albania and Yugoslavia—, the states now under Russian hegemony, such as Rumania, Bulgaria and Poland. Small Moslem groups have recently settled in many North American and South American cities [4], in the West Indies and in Australia [5].

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[1] *United Nations,* Demographic Yearbook, 1962, Table 2, p. 124, New York, 1962.

[2] Masdoosi, p. 82.

[3] Bowman, I., The Mohammedan World, p. 64, *Geographical Review,* vol. XIV, No. 1, January 1924.

[4] Hazard, p. 5.

[5] Massignon, p. 428.

It thus appears that Moslem World resembles two great crescents. Their four horns branch from the hub zone of the Middle East. The northern crescent forms a belt of more than two thousand kilometres in breadth, covering the south and east of the Mediterranean and separating Europe geographically from the densely populated lands in south and east Asia. The southern crescent encircles the Indian Ocean except for some stretches in India and Ceylon. From the hub extends a wedge towards central Asia. There is a third minor crescent round the Abyssinian Plateau in East Africa. The crescentlike home that encircles the Indian Ocean has an archipelago of Moslem nations in the East Indies and some scattered communities in the high seas of the Pacific facing East Asia up to Korea. They are the outlying islands —or the satelites— that are attached spiritually to the main Moslem land which forms an intercontinent in the core of the Eastern Hemisphere.

IV. — MAJOR AREAS OF CONTRADICTING ESTIMATES.

Table 2 shows the size of Moslem population distributed by continents. It is based on Masdoosi's estimates of 1951 with a grand total of 520.7 million [1], using the annual average rate of increase for the whole world and for each continent computed in the United Nation's Demographic Yearbook 1962 for the period (1950-1961).

It should be noted that the grand total computed for the Moslem population in Table 2 for the year 1961, is slightly higher than the previously computed one of 621.7 million. The difference is attributed to the ways used in computing each of them. The lower was computed directly from the grand total of 1951. For matter of comparison it is used in Table 3. The higher was computed according to the natural increase of each continent.

A rough grand total of 625 million can be accepted for the Moslem population in 1961. It is obvious that the Moslem point of view varies widely with the western estimates. This variation is shown in Table 3. Its estimates are computed from Table 1 and raised from 1951 to 1961 using the same annual natural increase for the whole world.

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[1] Masdoosi, p. 71.

TABLE 2

DISTRIBUTION OF MOSLEMS BY CONTINENTS IN 1961 (in millions)

CONTINENT	MOSLEMS IN 1951	ANNUAL INCREASE %	MOSLEMS IN 1961
Africa	107.7	2.1	133.1
Asia	390.0	2.0	475.4
Europe	17.2	0.8	18.6
New World	0.9	2.3	1.1
Total...	520.7	—	628.2

TABLE 3

ESTIMATES OF THE WHOLE MOSLEM POPULATION IN 1961 (in million) AS REPRESENTED BY DIFFERENT REFERENCES (ANNUAL INCREASE 1.8 %).

REFERENCE	ORIGINAL ESTIMATES		MOSLEMS 1961
	Year	Moslems	
Masdoosi	1951	520.7	621.7
Hazard	1953	390.0	448.5
Massignon	1954	368.0	416.7
Fernau	1955	335.0	388.2
National Catholic Almanac	1957	416.6	447.4

Let us now turn to discuss the major problem areas which cause this gulf between the two points of view about the Moslem population.

1. CHINA :

China is perhaps the country in which we meet with the widest variations in estimating the Moslem population. Moslems were reported to be ten millions in the 1953 census [1]. The same figure was stated by Massignon [2]. Formerly, official estimates put the figure at 30 million [3]. The Statesman's Yearbook (1964-1965) states that their total is estimated at 5% [4] of the population i. e. 35 million if we accept the Chinese population as 700 million for the year 1962 [5]. Nearly, the same percentage is accepted by Hazard [6]. Von Grunebaum mentions Moslem population there—excluding Sinkiang—as 9% of the total population of China [7], i. e. 42 million : a figure that can be rectified to 63 million for a population of 700 million. If the population of Sinkiang, Kansu and Ningasia—where the Moslems are in clear majority—be added, the population would be approximately 70 million. This figure that may seem overestimated in the sixties was—surprizingly enough—mentioned by Zwemer (1907) while discussing this problem. Zwemer's quotations varied between 30 and 70 million [8]. If we accept the lowest figure of Zwemer at the turn of the twentieth century, i. e. 30 million, then 70 million will not be far beyond accuracy in the six ties. Some Moslem scholars raise the figure to 80 million according to Chinese sources [9].

Taking a comparative view of all the Moslem and non-Moslem sources, Masdoosi accepts the figure given by von Grunebaum with slight modification, namely, that Moslem population is at least 10% [10], thus the

[1] *Worldmark Encyclopedia of the Nations,* vol. 2, p. 57, Harper and Row, New York, 1963, see also, MUHAMMAD MAKUN (MA CHIEN), How Muslems Live Today, In : China Reconstructors, *China in Transition,* p. 202, Peking, 1957.

[2] *Op. cit.,* p. 427.

[3] *Worldmark Encyclopedia,* vol. 2, p. 57.

[4] *Op. cit.,* p. 877.

[5] Estimated population of mainland China in Jan. 1964, was 735 million. See *Statesman's Yearbook* 1964-1965, p. 876.

[6] *Op. cit.,* p. 5. It is 4.8%.

[7] PHILBRICK, A.K., *Muslem Population by Political Areas,* 1954 : being front map in : Von Grunebaum, G.E. (editor), *Unity and Variety in Muslem Civilization,* The University of Chicago Press, 1955.

[8] MASDOOSI, p. 37.

[9] *Ibid.*

[10] *Op. cit.,* p. 39.

number of Moslems in China comes to about 70 million. It does not differ widely from Grunebaum's accepted percentage of 9% from which an estimate of 63 million has been computed for 1962, if natural increase is not practically handicapped by any imposed ideological factor which results in the decrease of the Moslem population in China. But accepting the official Chinese estimate of 10 million means that Moslem population there is passing a critical phase in which Moslem numbers are brought down from 30 million to 10 million in a few years.

It would seem more reasonable to adopt the higher figure than to ascribe the lower one to probable maltreatment of the Moslems by the Chinese authorities.

2. U. S. S. R. :

The Moslem population in U. S. S. R. is still a matter of controversy and debate. The total number of people belonging to groups and nationalities traditionally Moslem by religion can approximately be reckoned—according to the 1959 census at 24.5 million. Of these the great majority, about 22 million, live in that part which since 1958 has been officially classified as the Asiatic part of the U. S. S. R. [1]. The larger groups live in the administrative divisions bearing their names (Uzbekistan, Turkmenistan, Tadzhikistan, Kirghizistan, Kazakhstan and Azerbaighan).

According to Massignon the Moslem population in the U. S. S. R. is 21.4 million [2]. They are 18.5 in the Atlas of Islamic History [3], 19.8 million after Fernau [4]. But Masdoosi estimates them at 40 million. He calculates this figure as follows : 22 million in the six Moslem Republics, 14 million of the Tatar, Bashkir and Caucasia; Moslems are also found in the five autonomous Republics of the Russian Federal Republic, and in the north and East Asian parts of the U. S. S. R. [5].

[1] Wheeler, G., *Racial Problems in Soviet Muslem Asia,* p. 65, Oxford University Press, 1962.

[2] *Op. cit.,* p. 427.

[3] *Op. cit.,* p. 5.

[4] *Op. cit.,* p. 304.

[5] *Op. cit.,* p. 43.

TABLE 4

Changes in the National Composition of the Population of Moslem Central Asia

REPUBLIC	NATIONAL COMPOSITION	1939 %	1959 %
Kazakhstan	Kazakhs	57.1	29.6
	Russians	19.7	43.1
	Ukranians	13.2	8.2
Kirghizia	Kirghiz	66.0	40.5
	Russians	11.7	30.2
	Ukranians	—	6.6
Tadzhikistan	Tadzhiks	78.4	53.1
	Uzbeks	17.9	23.0
	Russians	—	13.3
	Ukranians	—	1.4
Turkmenistan	Turkmenians	72.0	60.9
	Uzbeks	10.5	8.3
	Russians	7.5	17.3
Uzbekistan	Uzbeks	76.0	62.0
	Russians	5.6	13.6

It is difficult to draw a definitive conclusion from these estimates. For the Moslem land in U. S. S. R. has been the field of many changes and upheavals which affected the population; these phenomena include migration of Russians into the area during the Stolypins' administration (1905-1911), the 1916 revolt, the Revolution and the Civil War, the migrations during the collectivization period (1928-1932), the evacuations and deportations carried out during the Second War and the settlement plan incidental upon the Kazakhstan grain drive, which is still in progress [1].

Table 4 gives an indication of the marked changes in the national composition of the populations of these republics drawn from Soviet

[1] Wheeler, p. 26.

sources. This has inevitably weakened the national character of the Asian republics [1].

In the U. S. S. R., after the Revolution, religion was looked upon as an integral part of the hated order from which Communion was emancipating mankind.

In 1929, a five-year plan was adopted for the purpose of carrying out more thoroughly the conversion of Russia into a Communist state. It entailed, on the cultural plane, the reshaping of public opinion, and particularly that of the younger generation, in accordance with the Communist ideology. In harmony with this policy, no believer in religion was permitted to teach in a Soviet school. Indeed, the schools became anti-religious [2]. In some respects the restrictions against religion were lightened after 1935. The Constitution of 1936 recognised freedom of both religious worship and anti-religious propaganda [3]. In 1939 the Government took measures to curb anti-religious activities. Members of different religions, including Islam, were said to pray in the same temples but at different times [4].

From « *Soviet Pedagogics* » (1955, No. 2, pp. 1-2), R. Conquest gives the following quotation, « The instruction and education of children must be conducted in such a way as not only to eradicate from some of them already existing superstitions and prejudices, but also to make all pupils immune from any religious ideas whatsoever. The task of the Soviet School is this sphere of its ideological and educational work is to bring up pupils, the future builders of Communion, as conscious and convinced atheists [5]. This policy has its manifestations and effects on the Moslem Community. The Arabic script, which was common to all Turkish languages, was abolished and replaced by a number of Latin

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(1) Robert Conquest, *The Last Empire,* p. 43, Ampersand Books, London, 1962.

(2) Latourette, K.S., *History of the Expansion of Christianity,* vol. VII, Advance through Storm, A.D. 1914 and after, pp. 76-77, Eyre and Spottiswoode, London, 1947.

(3) *Op. cit.,* p. 80.

(4) *Op. cit.,* p. 86-87.

(5) Conquest, pp. 13-14.

scripts in the 1920 s and early 1930 s [1]. Before the establishment of the Soviet régime there had been some 12,000 mosques in Turkestan and a further 3,000 in Khiva. There were some 340 mosques in the town of Bokhara alone. In 1959 there were only 200 central mosques and 1,000 district mosques in the Soviet Central Asian Republics. There are now only two medresseh (Theological school) one in Tashkent, the other in Bokhara, to serve the needs of Islam in the Soviet Union as a whole [2].

Islam still continues in the U.S.S.R. It passed through many adversities. The way in which the U. S. S. R. was isolated from the outside world prevented the aquisition of a complete picture by those beyond the borders of the country. Yet from time to time fragments of information were obtained which gave some inkling of what a well-rounded description would presumably present [3]. There is evidence of the persistence of Islam, but it has been separated from all its vital roots [4]. How far future generations of Moslems will become assimilated with the Russians or with the standard type of *homo sovieticus* remains a matter for speculation [5].

3. Tropical Africa :

There can be no doubt that Islam is still spreading in Tropical Africa [6]. It is spreading along a front that extends across the continent from the Atlantic to the Indian Ocean, marching southwards and depending on the dynamic influence of the African Moslem peoples. The profound effects of Islam in Tropical Africa have repeatedly been noticed. « It brought with it a new civilization, which gave the Negroid races the distinctive cultural character which they bear to-day, dominating their

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(1) *Op. cit.,* p. 95. See also : John Gunther, *Inside Russia Today,* p. 461, Harper, New York, 1958.

(2) Conquest, pp. 111-112.

(3) Latourette, vol. VII, p. 84.

(4) Gunter, *Op. cit.,* p. 461.

(5) Wheeler, p. 62.

(6) Anderson, J.N.D., *Tropical Africa : Infiltration and Expanding Horizons,* p. 278. In : Grunebaum, G.E., *Op. cit.,* 1955.

political life and social institutions... It has broadered the outlook, raised the standard of living by creating a higher social atmosphere, and has conferred on its followers dignity, self-respect and respect for others. It has enabled the Sudanese Negro to become a citizen of the world [1].

Fernau says that the Outer World has given little attention to the quiet Islamic expansion, whose political importance to the future of Africa is only gradually being revealed. The association with the centres of Islamic life is active enough, and the unrest that has taken hold of the Islamic intercontinent is thus spreading far into Africa [2].

The traditional African cultures are gradually yielding to Islam or Christianity with its different churches. They sometimes have their own African churches, the « Young Church» where Africans spread the Gospel themselves and where there is a strong tendency to represent God as a national figure [3]. As Simon's says : « Islam is a native and independent Asian-African religion, whereas Christianity, and particularly Catholicism, has white leaders in Europe... Islam with its seat in the non-white world, is taken as a representative religion for many non-whites. It draws no rigid line between priest and layman, its doctrines are uncomplicated and the Moslems do not keep apart from the natives but live among them... There is also a basic Islam» [4]. This point of view is valid with some amendments. For Islam, as we have seen before, does not accept any colour bar. It is not a religion of non-whites or for them. It demands equal respect for all mankind, whom God chose to create with skins of differing colours [5]. Simons summarizes the status in Tropical Africa by saying : « If Christendom wants to avoid being outnumbered, it will have to try to find a « basic Christianity», a new ABC for the areas to be converted» [6].

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(1) Meek, C.K., *The Northern Tribes of Nigeria,* vol. II, pp. 4-5, Oxford University Press, 1925.

(2) *Op. cit.,* p. 35.

(3) Simons, R.D. G.Ph., *The Colour of the Skin in Human Relations,* p. 58, Elsevier, Amsterdam, 1961.

(4) *Ibid.,* p. 63.

(5) *The Holy Qur'ān,* 30 : 22 and 35 : 27-28.

(6) *Op. cit.,* p. 63.

In Tropical Africa Islam has established innumerable scattered communities through the zone of deep forests, essentially in the cities and along the coasts, where the Moslems coming from the north often discover Moslems of other origins. In Central, Eastern and Southeastern Africa, Moslem expansion is continuing energetically. In South Africa, Islam is represented mainly by Indian traders. Also in Eastern Africa, it has followed the trade routes and reached as far as the Congo, where strong groups of Islamic converts are found. Just recently Islam has started to extend its influence into the countryside. It is gaining foothold in the bush and in the newly formed mining towns. In Eastern Africa it has reached the pastoral peoples where the process of conversion has recently begun [1].

TABLE 5

Moslems in Tropical Africa (in millions)

REFERENCE	YEAR	ESTIMATES
Masdoosi [2]	1951	63.3
Hazard [3]	1953	33.9
Massignon [4]	1954	37.0
Fernau [5]	1955	35.0
Monteil [6]	1964	40-50

Table 5 shows the different estimates of the Moslem population in Africa south of the Sahara. It reflects as we have seen before in China and the U. S. S. R., different points of view which will continue to exist until accurate censuses are undertaken in all, or at least, the majority of the African countries.

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(1) De Planhol, X., *The World of Islam,* p. 54, English Translation, Cornell University Press, New York, 1959.

(2) *Op. cit.,* Computed from tables 5-E, F and G, pp. 65-68 respectively.

(3) *Op. cit.,* Computed from p. 5.

(4) *Op. cit.,* Computed from p. 428.

(5) *Op. cit.,* Computed from Appendixes I and II, pp. 303-305.

(6) Monteil, V., *L'Islam Noir,* p. 9, Editions du Seuil, Paris, 1964.

V. — THE THREE BELTS.

1. The status of Moslems both in the U. S. S. R. and in China is similar in many respects. In both cases the natural diffusion of Islam has been hampered by political and cultural measures—that is, if we accept the number of Moslems as given by official statistical returns. Under this régime the northern and north-eastern sector of the Moslem World forms a static belt, if not a « receding belt».

2. This belt differs from the «main belt» of country that extends from the Atlantic to the Pacific—from Mauritania to Indonesia—where the Moslem population increases naturally. In this main belt Islam had its birth and continues to have the main centre of its strength.

The passing of the Caliphate and the demotion of Islam in the new Turkey, increased the prominence of Egypt (U. A. R.) in the Moslem World. That and nationalism, together with the presence in Cairo of Al-Azhar, the outstanding centre of Islamic education and scholarship, contributed to the conviction that Egypt (U. A. R.) should be the leader in Islam [1].

3. There is a third belt in Africa south of the Sahara where Moslems increase in two ways : (*a*) natural increase and (*b*) new followers accepting Islam. Here the missionary spirit of Islam is still active and fruitful. This is the « advancing belt» which counterbalances the losses of the « receding belt» (Map 1).

VI. — THE ECONOMIC SIGNIFICANCE.

1. The Arid Sector :

A great part of the Moslem World receives less than 250 mm. of annual rainfall, with the effect that huge areas of vast region can support only the thinnest population or none at all. This arid sector extends from

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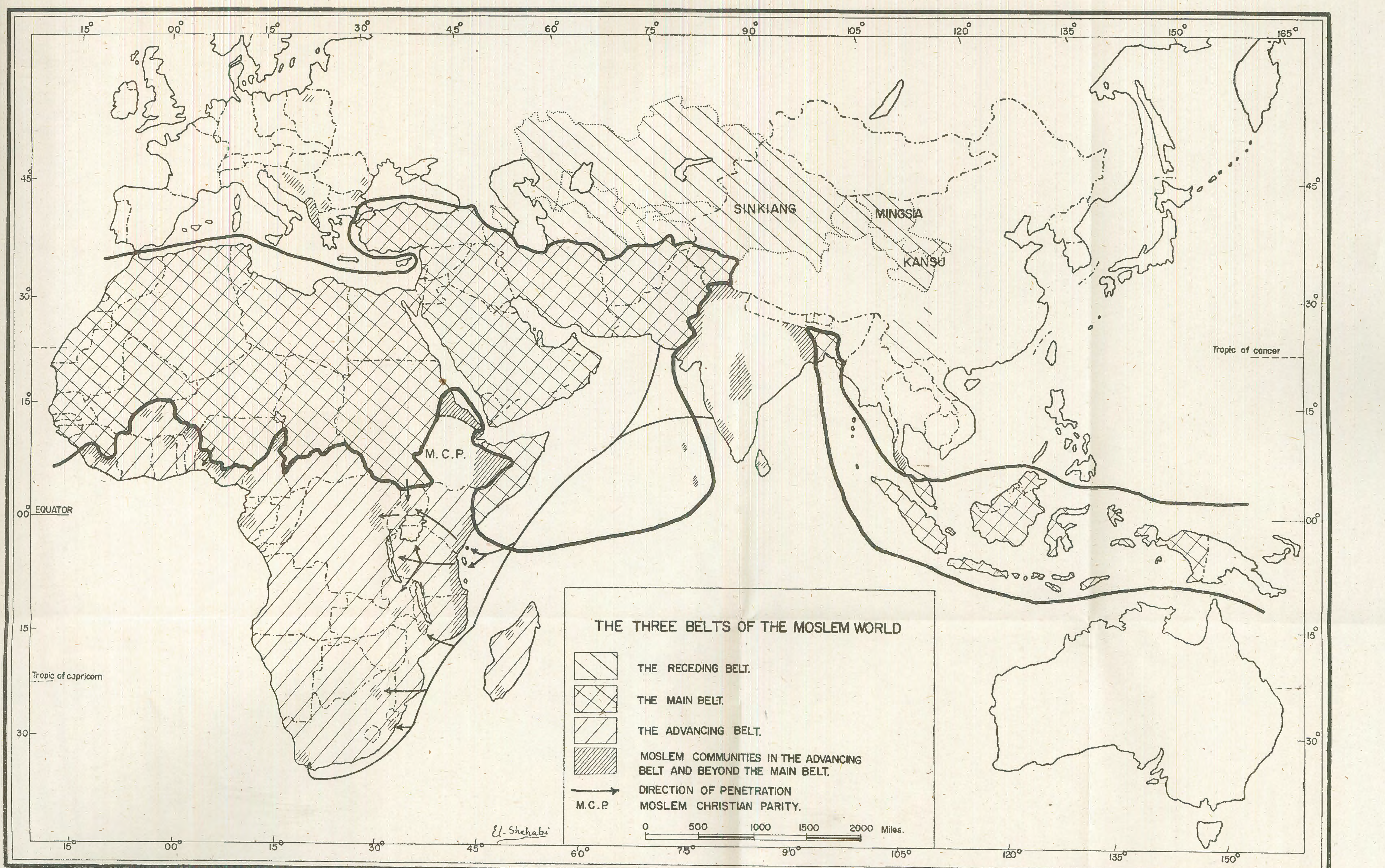
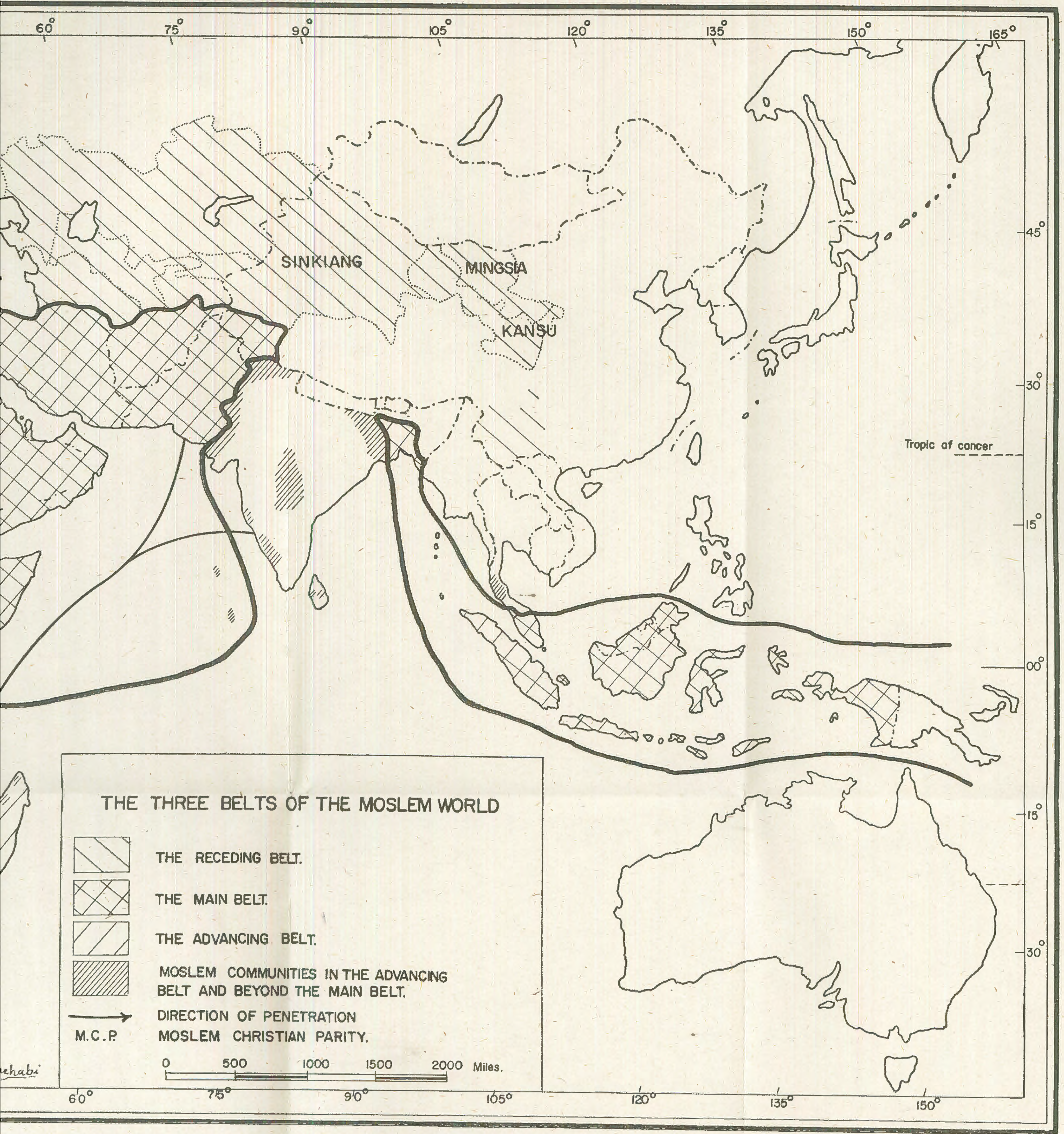
[1] Latourette, vol. VII, p. 257.

MAP 1


THE THREE BELTS OF THE MOSLEM WORLD
THE RECEDING BELT.
THE MAIN BELT.
THE ADVANCING BELT.
MOSLEM COMMUNITIES IN THE ADVANCING BELT AND BEYOND THE MAIN BELT.
DIRECTION OF PENETRATION
M.C.P. MOSLEM CHRISTIAN PARITY.
0 500 1000 1500 2000 Miles.
SINKIANG
MINGSIA
KANSU
M. C. P.
EQUATOR
Tropic of cancer
Tropic of capricorn
El-Shehabi

MAP 1



THE THREE BELTS OF THE MOSLEM WORLD
THE RECEDING BELT.
THE MAIN BELT.
THE ADVANCING BELT.
MOSLEM COMMUNITIES IN THE ADVANCING BELT AND BEYOND THE MAIN BELT.
DIRECTION OF PENETRATION
M.C.P. MOSLEM CHRISTIAN PARITY.
0 500 1000 1500 2000 Miles.
SINKIANG
MINGSIA
KANSU
Tropic of cancer
60°
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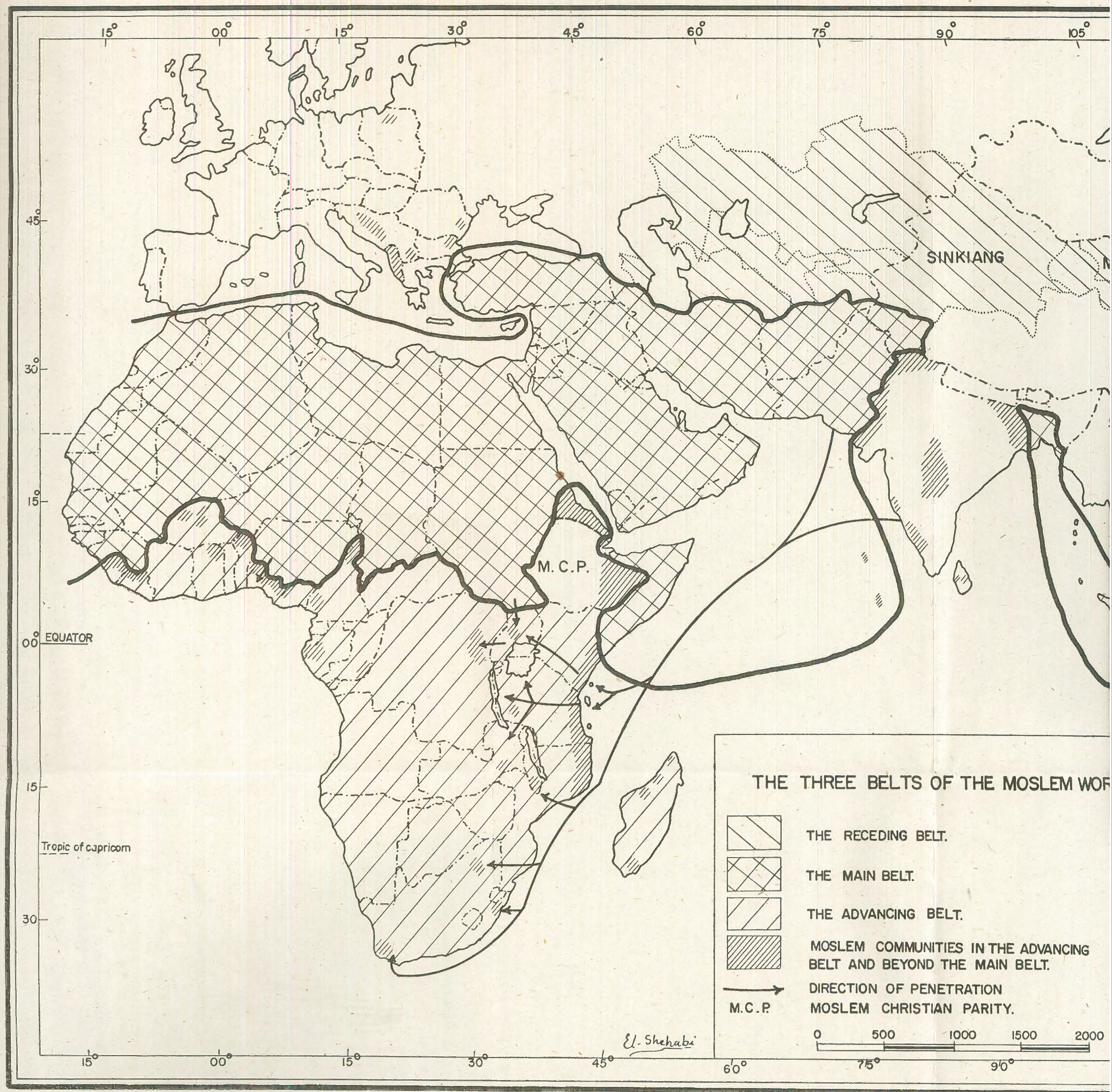
MAP 1



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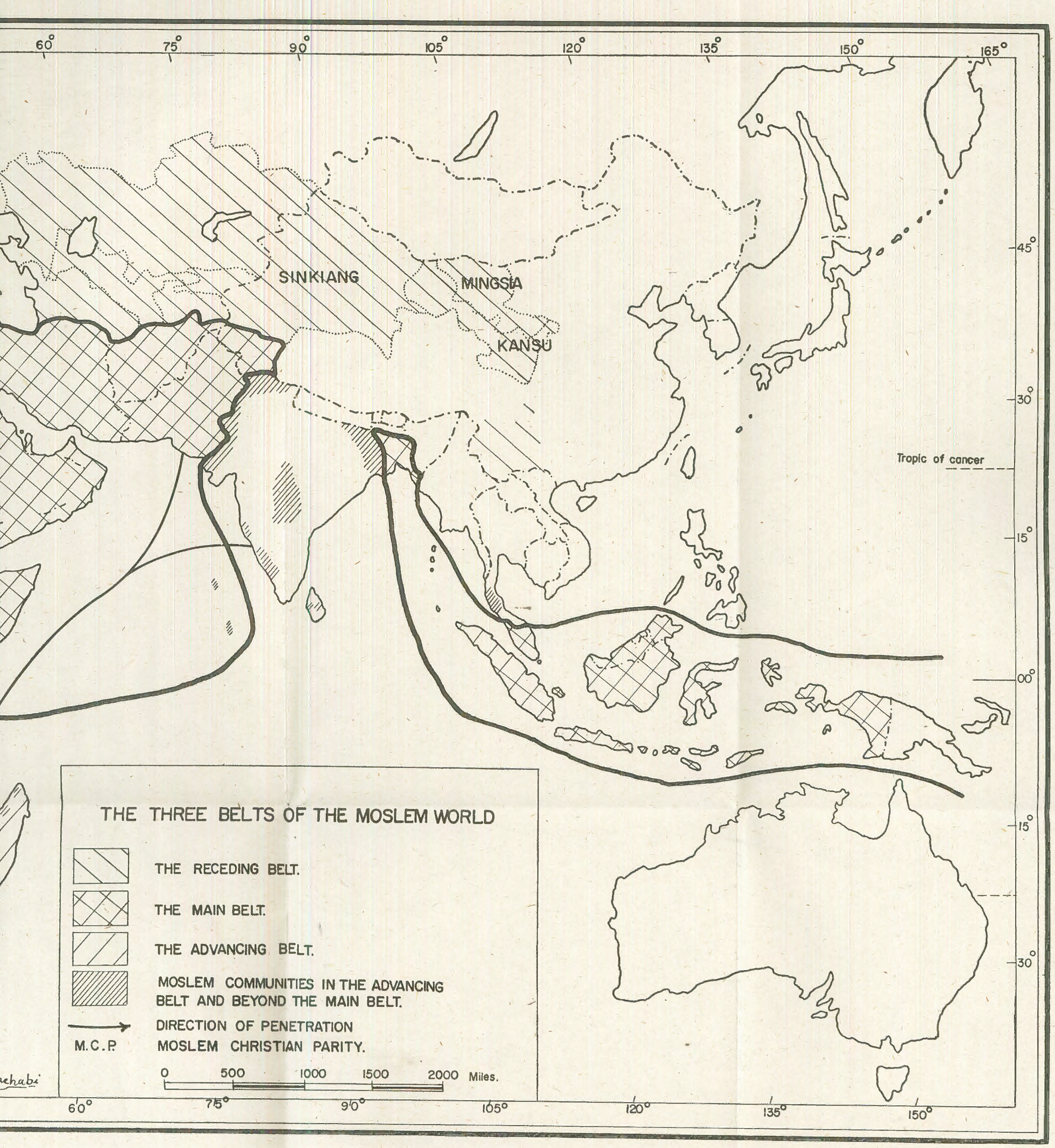
MAP 1



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THE THREE BELTS OF THE MOSLEM WORLD
THE RECEDING BELT.
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DIRECTION OF PENETRATION
M.C.P. MOSLEM CHRISTIAN PARITY.
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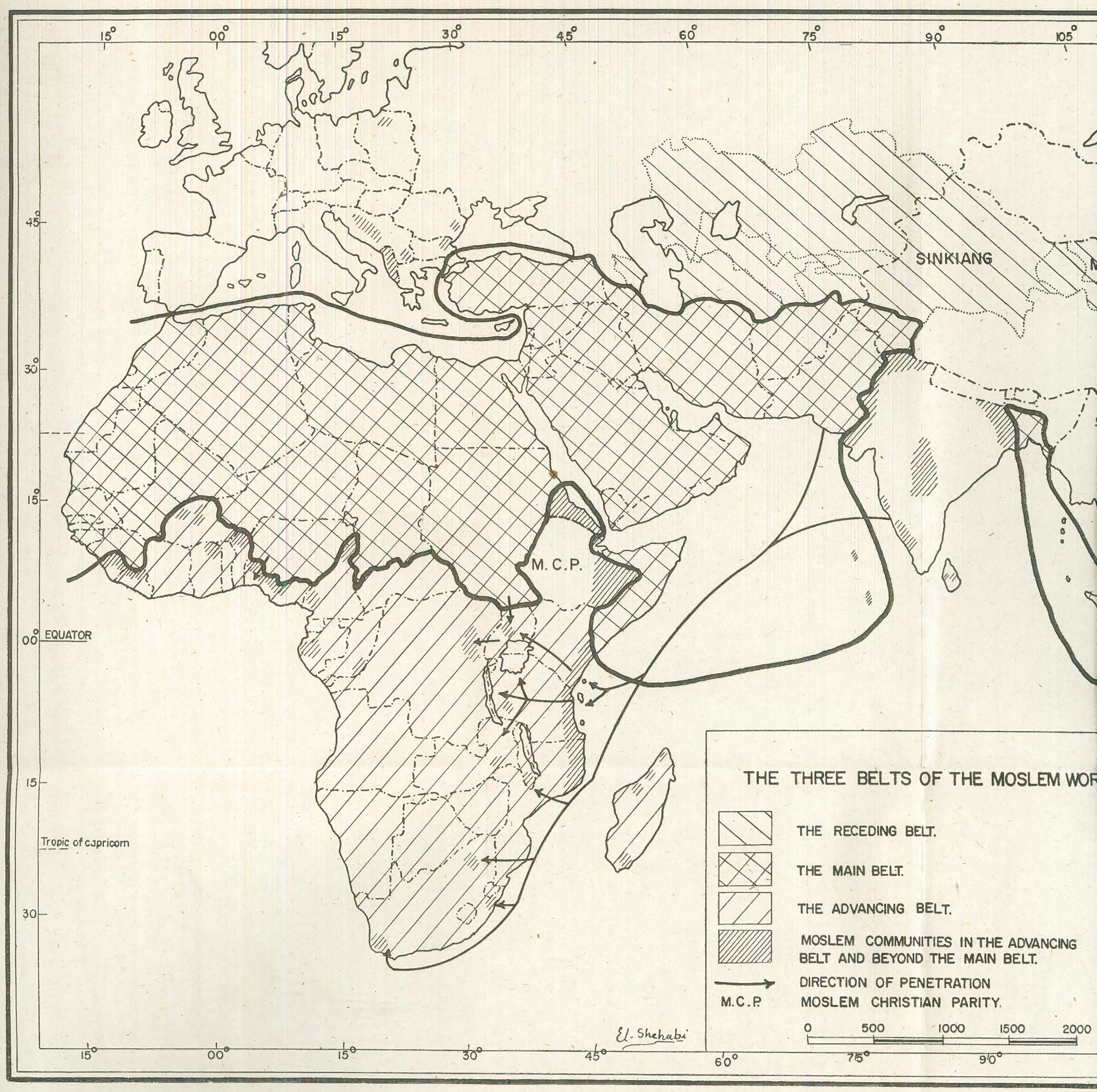
MAP 1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THE THREE BELTS OF THE MOSLEM WOR
THE RECEDING BELT.
THE MAIN BELT.
THE ADVANCING BELT.
MOSLEM COMMUNITIES IN THE ADVANCING BELT AND BEYOND THE MAIN BELT.
DIRECTION OF PENETRATION
M.C.P. MOSLEM CHRISTIAN PARITY.
0 500 1000 1500 2000
El-Shehabi
15°
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75°
90°

the Atlantic to West Pakistan—a geographical factor that has important economic manifestations :

(*a*) Agriculture is—to a great extent—concentrated in the fluvial valleys : The Nile, Tigris, Euphrates, Indus and where underground water is available.

(*b*) This type of agriculture when developed depends largely on irrigation schemes that control the river waters. In Egypt (U. A. R.), there is an elaborate irrigation system, deeply rooted in history. The High Dam is its corner stone. Other systems and development schemes are established in the Sudan, Iraq, West Pakistan and the Moslem Republics of the U. S. S. R.

(*c*) The physical environment in the dry sector of the Moslem World is very suitable for growing certain crops, especially cotton. The Moslem World contributes about 35% of world production of this crop.

Turning to mineral resources, this dry sector plays an important role in the world economy. If we draw a straight line on the map northward from the Arabian Gulf through the Caspian Sea to the foot of the Urals, it will be found that the line, running almost along the fiftieth degree of longitude, marks the geographical axis of the Moslem World. The discovery would have been of no particular significance if it were not along that line, according to the present state of research, lie the greatest oil deposits in the world. There is naturally no connection between the spread of Islam and the accumulation of oil deposits beneath the soil. It is a chance circumstance of which the world only became aware in the last half-century [1].

These oil fields and reservoirs consist of two great basins :

1. The southern—in the Middle East—encircles the Arabian Gulf where the Arabian and Iranian oilfields exist.

2. The northern is in the U. S. S. R. It includes the oil fields in the Caucasus, round the Caspian, in Central Asia (the Turkmenistan and Uzbekistan) and the Ural-Volga [2].

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(1) Fernau, p. 255.

(2) Baransky, N.N. *Economic Geography of the USSR*, p. 32, Moscow, 1956.

The southern basin is the second oil producer after North America. This area, together with Latin America, are the main contributors to the oil trade. At present, the Middle East produces about one third of the world's crude oil. It contains two thirds of the world reserves. Kuwait is the leading producer. It is followed by Saudi Arabia, Iran, Iraq, Qatar, Bahrain, the U. A. R. (Egypt) and Abu Dhabi. The production of Algeria-Sahara and Libya has exceeded (in year 1963) any other Arabian country in Africa, and ranks next to Iraq [(1)].

In the U. S. S. R., the Moslem Republics contribute 90% of the whole oil production of the country. They also contain the major part of its reserves. When the Russians began their scientific mineral survey, they discovered enormous deposits of coal, copper and gold in these states. In a short time Karaganda coalmines have become the third producer in the U. S. S. R. after Donbas (Donez) and Kuzbass [(2)]. Balkash mines contribute one third of the Russian copper production. The greater part of the rest comes from Moslem areas. About half of the whole production of nickel in produced in Kazakstan. This state is responsible for half of the Russian zinc. As regards diversity and abundance of its mineral resources, Kazakstan is one of the richest countries of the World. Every year new mineral deposits are discovered in the republic [(3)].

In the Far Eastern extension of the Moslem World, Indonesia (even if it is not in the Arid Sector which is being discussed now) contributes about 2.5% of the total world production and about 1.5% of the oil reserves.

Summing up the above survey, it can be concluded that the Moslem World—as a whole— contributes between 70% and 75% of the world oil potentialities.

The drought and high temperature cause high evaporation from water bodies of this arid sector. This can explain the abundance of mineral salts in the Dead and Caspian Seas, and the industries based on these salts.

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(1) *Statesman's Yearbook* 1964-1965, pp. XXVI and XXVII.

(2) Cole, J.P., and German, F.C., *A Geography of the USSR*, p. 113, Butterworths, London 1961.

(3) Barabsky, p. 392.

2. The Humid Sector :

Various types of climate are represented in the humid sector of the Moslem World :

(*a*) The Mediterranean Type with its winter rains in North West Africa and the Asiatic shores of the Levant.

(*b*) The Sudanese Type with its summer rains south of the Sahara. It extends from the shores of the Atlantic to the western slopes of the Ethiopian Plateau. It is the «Broadway of Africa».

(*c*) The Monsoon Type with its heavy summer rains in East Pakistan.

(*d*) The Equatorial Type in East Africa, Malaysia and Indonesia.

This variety of climates is reflected in the ways of life, agricultural crops, density of population, political and economic problems.

The rainy tropical lands of the Moslem World produce-among other things-rubber, jute, tea, rice, spices, and quinine. The temperate lands produce olive, citrus fruit, grapes and their by-products. The Sudanese belt is the main producer of gum. All the Moslem states of this humid sector are generally self-sufficient in their subsistance crops.

Turning to mineral products, Mediterranean Africa produces high percentages of some important minerals. After agriculture, mining is Morocco's most important industry. Phosphates (7.95 million tons) represented 55% of total mineral production value in 1961. Morocco is the world largest exporter of phosphates (accounting for about 45% of total world exports) and its second greater producer (after U. S. A.). At Djerida, in the Oujda region, is the only anthracite mine in the Mediterranean area, with reserves estimated at over 100 million tons. Manganese, of which Morocco is the world's fifth largest producer, reserves are estimated at over 7.5 million tons. Morocco ranks third in world production of cobalt, with recent annual output over 12,000 tons [(1)].

In Algeria, the phosphate deposits at Djebel Onka are claimed to be the largest in the world, with reserves estimated at over 500 million

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(1) *Worldmark Encyclopedia*, Vol. I, p. 173.

tons and a potential annual output of 1.3 million tons of ore or 800,000 tons of enriched ore with a phosphate content of 75%. Oil production is estimated to rise further to 40 or 50 million tons in 1970. Important as oil is, however it is felt that natural gaz will be an ever greater asset in developing the Algerian economy, both as a source of energy and a raw material. Besides oil and natural gas the Sahara is believed to have exploitable quantities of iron, manganese, coal, phosphate, tin, copper, tungsten, and salt [1].

In Tunisia, phosphate rock, the chief mineral, is found in extensive deposits is the south. The annual output of phosphates amounts to one-tenth of world consumption [2]. High grade iron ores are mined in the north, while lead and zinc mines are widely dispersed [3].

In South and South East Asia, the Moslem states contribute to mineral products and trade. Indonesia and Malaysia produce about half of the world production of tin [4] and about 6% of world exports of bauxite [5].

7. —THE POLITICAL STATUS.

This is a birds' eye view of the geographical setting of the Moslem World. It can interpret—to some extent—the strategic importance of their home and throw some light on the Moslems' political problems and on the conflict between them and the imperialist powers :

After the First World War, the major part of the Moslem World was ruled by foreign forces. All the African Moslem peoples, directly or indirectly, were ruled by the United Kingdom, France, Spain, Portugal and Italy. In Asia, independent Moslem states were Iran, Turkey, Yemen, Saudi Arabia and Afghanistan with a total population

(1) *Op. cit.*, vol. I, p. 9.

(2) Barbour, N. *A survey of North West Africa*, p. 332, Oxford University Press 1962.

(3) *Worldmark Encyclopedia*, vol. I, p. 298.

(4) *For year 1962*. USA Department of Interior, 1962, vol. I, p. 1222, computed from table 21.

(5) For year 1961, *op. cit.*, vol. I, p. 301, computed from table 17.

of well over 50 million. This state of affairs represented the lowest water mark of Moslem power. Some of these independent states (or formally independent), even turned their backs to the Arabs. And thus, few as they were, they could not work harmoniously for the cause of Islam. Some adopted a bare self-seeking policy which aimed solely at advancing their own narrow interest.

Moslems did not accept foreign domination for long, and continued their struggle for independence. Some of them attained their independence between the First and Second World Wars. After the Second World War, millions of Moslems threw the yoke of tyranny off their shoulders. New Moslem States won their independence : Pakistan (93 million-census 1961), Indonesia (97 million-census 1961) and Malaysia (10 million-1962 estimate). All the Moslem states of North West Africa and the Republic of the Sudan won their independence. The wind of freedom swept southwards over Africa to the Moslem peoples south of the Sahara. It was natural—after independence—that the Moslem nations and states tried to strengthen their relations.

Considering the various relations that bind the Moslem World, the cultural relations, in their widest sense, are the deep rooted and most consistent. When the Moslem World lost its political unity and economic prosperity, the cultural relations were the elements that kept the Moslem belief in their unity and were the base from which the Moslem power advanced to achieve other aspects of unity in the political and economic spheres. From the Islamic point of view, it is not right to begin discussing the Moslem unity from its economic and political possibilities in spite of their importance, for this unity and the efforts to achieve it are commandments that a Moslem cannot ignore [1]. There is no fixed or preconceived pattern for this unity. All that is aimed at in Islam, is to fulfill its ends through the general and broad principles that are mentioned in the Holy Qur'ān and the sayings of the Prophet. This can interpret the flexibility and variety of the means which the Moslem nations in their contemporary evolution are trying to exercise in their advance towards unity. They are not satisfied to confine it to the realm of ideas, but they

(1) *The Holy Qur'ān*, 3 : 103, 21 : 92 and 32 : 52.

try to cement it by material political and economic bilateral and multilateral goals. It is obvious that this cooperation is more vivid and effective in the case of the Arab nationality movement—the core of the Moslem World. For Arabs are directly facing the challenge of Israel with its manifold aspects : the control of the River Jordan waters, military aggressions, the troubled boundaries ... This state of affairs led them to adopt common measures which, when undertaken, will strengthen the political ties among the Arab nations.

The political climate after mid-century differs widely from what I. Bowman discussed after the First World War. He urged the colonial powers to « leave the Mohammedan world to itself so far as possible; but above all, if force must be exercised, to exercise in strategic regions of high productivity or at strategic points where special sustaining resources like oil, phosphates, and tin may be developed». He considered how to make use of the « persistent sectarian division which ... has thwarted every leader who sought Mohammedan solidarity. By this we mean not merely the broad division between Sunnis and Shiahs but the large number of minor sects that thrive in every quarter of the Mohammedan World» [1].

It is true that the strategic points are still the foci of imperialists. What happened in the Canal Zone (U. A. R.) in 1956 is common knowledge, when the tripartite aggression (United Kingdom, France and Israel) was directed against Egypt. It was disastrous to the aggressors. Since its clearance after aggression, the Suez Canal has been run by Egyptians to the advantage of world trade and humanity at large. This was an event which went to prove that Arab solidarity was on a level above «sectarian divisions»—a factor that colonial powers thought to be a major handicap facing Arab and Moslem solidarity.

The policy of «marginal control» that Bowman [2] advocated for ruling the Moslem World has become ineffectual, for in nearly all the cases where this policy was applied, states have gained their independence.

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[1] BOWMAN, *op. cit.*, pp. 73-74.
[2] *Op. cit.*, p. 71.

CONCLUSION

1. It seems that there is a southward shift in the physical lay out of the Moslem World. There are losses in the north and gains in the south.

2. Accordingly, we can distinguish three major belts in the Moslem World :

(*a*) The receding belt : which lies in Europe and Central Asia, where Moslems look as if receding, if we ever accept the official statistical returns. This receding belt can be divided into :

i. The newly receding sector which we may term as the « neo-receding» in Eastern Europe and Central Asia. Its recession has begun in the twentieth century with the adoption of the newly materialistic ideology.

ii. The « palaeo-receding sector» which is found in Western Mediterranean Europe. This recession which took place in the fifteenth century marks a phase of the Crusades.

(*b*) The main belt : lies between the Atlantic shores in Africa north of the Sahara and Indonesia, where Moslems increase naturally.

(*c*) The advancing belt : lies in Africa south of the Sahara. Moslems here increase in two ways :

i. Natural increase.

ii. New adherents embracing Islam.

3. A new centripetal force with cultural, political and economic manifestations is growing within the main belt particularly in its Arabic territory which has manifold relations with the two other belts.

4. The strategic impact of the Moslem World is ever increasing despite its losses, in view of the freedom gained by its peoples, the solidarity of their national movements and the economic vantage point they have which emanates from their natural resources and the relevant economic projects. All these factors put them in a position to strike a balance between the two opposed blocs.

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STUDIES ON THE ECOLOGY OF THE RED SEA COASTAL LAND

II. THE DISTRICT FROM EL-GALALA EL-QIBLIYA TO HURGHADA*

BY

M. KASSAS AND M. A. ZAHRAN

INTRODUCTION

Geology and Geomorphology

El-Galala El-Qibliya (southern Galala) is a mass of limestone that rises to heights of more than 1200 m. on its east side (seaward side) and slopes gradually till it merges into the limestone plateau on the inland side. It is essentially an Eocene block fringed by Cretaceous rocks : limestones and sandstones. This block is bounded on the north side by Wadi Araba.

South of El-Galala El-Qibliya extends the great chain of the Red Sea basement-complex mountains. This chain of rugged peaks extends continuously from Gebel Umm-Tinâssib (alt. 1104 m. lat. 28° 30′) to the Sudan border and further south to the Ethiopian plateau. Within the area surveyed in this report, the basement-complex chain comprises some of the highest peaks in Egypt : Gebel Gharib (1751 m.), Gebel Abu Dukhan (1662 m.), Gebel Qattar (1963 m.), and Gebel Shâyib El-Banât (2184 m.).

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* Part I. — The district of Gebel Ataqa and El-Galala El-Bahariya, *in this Bulletin,* T. XXV (1962), p. 129-175.

The area surveyed here extends between lat. 29° N. and lat. 27° N. Within the northern part (lat. 29°-lat. 28°) the chain of hills and mountains is separated from the shore by a coastal plain with an average breadth of 15-20 km. This gravel-covered plain is dissected by a number of drainage channels which descend from the hills, and it includes a number of coastal saline depressions the most extensive of which is the Mallaha depression which extends for some 30 km. (20-50 km. south of Ras Gharib).

The geology and the geomorphology of the southern part (lat. 28°-27°) present a much more complicated pattern than that of the northern part. In its north there is a small peninsula (Gebel Zeit) with a granitic core rising to 400 m. above sea level and a fringe of Cretaceous and Miocene sedimentary formations : dolomitic limestones and gypsum. The extensive coastal plain is divided by the Esh-El-Milaha ridge (500 m. O.D.) which extends for about 80 km. in a northwest — southeast direction (parallel to the shore line). The eastern flank of this ridge is formed of igneous rocks (felsites, andesites, granites and syenites), the western flank is formed of sedimentary rocks of Cretaceous (Nubia sandstone and limestones) and Eocene (limestones) ages. The southern extremity of the whole ridge is formed of Miocene coralline limestone : the Abu-Shar El-Qibli block. Eastward (seaward) of the Esh-El-Milaha ridge extends a narrow (*c* 5 km.) alluvial plain covered with gravels and boulders (granitic and limestone rounded fragments). To the west (inlandward) of the ridge stretches an extensive gravel plain which separates it from the main basement-complex range. The main drainage systems descend from the inland range, cross the inland gravel plain, cut their ways through bottle-neck passages across the Esh-El-Milaha ridge and extend further across the coastal plain.

The shore-line in the surveyed area, especially the southern part (lat. 28°-27° N.), comprises a number of bays and lagoons and the off-shore comprises numerous islands. The shore of a bay is usually fringed by a crescent-shaped area of salt marsh habitat. This is followed by the coastal plain which forms, together with its wadis, an ecosystem with recognizable character. The wadis traversing the basement complex country have their characteristic vegetation.

Reference may be made to what is locally known as the *nakkat* (arabic for dropper). A *nakkat* is a crack or fissure that oozes a continuous trickle of water. These *nakkats* are found only in the summit parts of the highest mountains and form the habitat of ferns and other moisture-loving plants. Mention may also be made to salt — or brackish — water springs that form, in certain wadis, sluggish streams of salt water. An example of this is found in the part of Wadi Milaha that cuts across Esh-El-Milaha ridge. See map in Fig. 1.

Climate

According to the *Climatic Normals for Egypt* (1950) the average annual rainfall at Hurghada is 3 mm. Hurghada (lat. 27° 14′ N.) is apparently far from the southern limits of the Mediterranean (winter) rain and from the northern limit of the tropical (summer) rain. The recorded rainfall for 1945 is 6.4 mm. all of which fell in May (summer rainfall); that of 1954 is 26.7 mm. most of which (25.7 mm.) fell in December (winter rainfall). On a single day, namely 8.11.1939, 41 mm. rainfall is recorded. The rain is obviously due to accidental cloudbursts and not to a widespread phenomenon; most of the years are rainless. It may be noted that Hurghada is situated at the entrance of the Gulf of Suez, and, together with the coastal land to its north, face a narrow body of water and do not benefit from the main mass of Red Sea water. By contrast, the coastal land further south receives a more regular winter rainfall (e.g. Port Sudan, see Ireland, 1949 and Kassas, 1957).

The Piche evaporation ranges from 10.4 mm. per day in December to 21.5 mm. per day in June. The annual mean is 15.2 mm. per day. This shows the intense aridity of the climate of the Hurghada district.

The vegetation of the coastal plain west of Hurghada indicates conditions of an extremely arid climate; but the vegetation types of the high mountain (over 1500 m.), the runnels that dissect their slopes and the wadis that collect the drainage at their feet indicate less arid conditions. It is presumed that the peaks of high mountains intercept some of the cloud moisture in the form of orographic rain or condensation. The moisture feeds the *nakkat* reservoirs and contributes to the water revenue of the runnels and wadis associated with the high mountains.

ECOLOGICAL ANALYSES

1. Vegetation of the Coastal Land

1.1 *Sample Areas*

The coastal belt surveyed in this study extends from Zâfarâna to Hurghada (*c* 265 km.). It exhibits the usual distinction between the littoral salt marsh and the coastal desert plain. To present the ecological data we shall first describe five localities in some detail, then we shall describe the floristic characters of the various plant communities and their ecological relationship. The five localities are :

- Mallaha (south of Ras Gharib),
- Wadi Dib,
- Ghubbet El-Zeit,
- Myos Hormos,
- Abu-Minqar Island.

1.11 *Mallaha*

This is an inland depression separated from the shoreline by an elevated raised beach, the surface of which is covered with gravels and boulders. On the inland side it is bounded by the rising slopes of the foot hills of the coastal mountains which include Gebel Gharib. The depression is a coastal drainage basin which is also fed with seawater through underground seepage; its bottom includes several small salt-water lagoons fringed by saline ground with surface salt crusts. This is, in turn, fringed by salt marsh vegetation.

A transect 140 × 20 m. was laid across the eastern side of this Mallaha extending from the sloping side of the seaward gravel embankment to one of the water lagoons. The transect cuts, in its middle part, across a body of sand dunes covered by a rich growth of *Tamarix passerinoides*. The relative ground-level is measured in relation to a zero point which is the level of the water in the lagoon (11.9.1960). Fig. 2 is a chart showing the distribution of the plant growth within the quadrats (14 quadrats each 20 × 10 m.) forming the transect.

It will be noted that quadrats 1-3 represent the sparse growth of *Zygophyllum album*. The ground level slopes down from 168 cm. to about 102 cm. Quadrats 4 and 5 represent the ground at the feet of the sand dune mass. The vegetation includes *Suaeda monoica, Nitraria retusa* and *Tamarix passerinoides*. Quadrat 5 is a part of the sand dune and is predominantly covered by *Tamarix* growth. Quadrats 6-12 represent a zone of sand dunes of different size, but are all covered by *Tamarix passerinoides*. Quadrats 6 and 7 cross a massive dune rising to the relative height of 395 cm. Quadrats 8-12 represent isolated smaller dunes studding the flat saline bottom of the Mallaha. Quadrats 13 and 14 represent the saline ground fringing one of the lagoons. The plant growth is a pure community of *Arthrocnemon glaucum*.

A number of soil sample-sets were collected from the various parts of the transect (see Table 1). Samples 74 and 75 represent the soil accumulated around *Zygophyllum album* growth, quadrats 1-3. The texture of the upper sample is finer than that of the lower sample (73) which includes some gravels and very coarse sands (6 + 10%). The soluble salt content of the upper sample is a little higher than that of the lower sample. The sulphate content is, in both samples, higher than the chloride content, this is much more pronounced in the lower sample.

Samples 76-79 represent a profile within a sandy hummock built around *Suaeda monoica*; quadrat 4. The lower samples (78 and 79) are coarser in texture than the upper samples. This is due to their being associated with the original cover of the erosion pavement on top of which the sand hummocks are built. The erosion pavements are usually covered by lag gravel and other coarse fragments. The total water soluble salt content varies within the profile. In the top sample (76) the chlorides are a little higher than the sulphates; in sample 77 the decrease in the total soluble salt is associated with the reduction of the chloride content but not the sulphate content. Sample 78 shows an increase in the content notably due to increase in the sulphate, but lower in the profile the salt content is much less (sample 79).

Samples 67-73 represent a profile across the upper layer of one of the *Tamarix* sand dunes, quadrat 6. The notable thing is the presence of salt layers alternating with sandy layers with lesser salinity. The salt

layers are associated with dead shoots of *Tamarix* and it is assumed that the development of the dune comprises successive phases of plant growth (*Tamarix*) and its being killed by salt accumulation. The uppermost salt layer (sample 68) is some 4 meters above the salt water-table. It is very unlikely that salinisation is due to flooding by saline water but is more probably due to accidental wind spray or due to the capillary rise of saline water and its eventual evaporation at the dune surface. The death of one phase of growth is apparently followed by a resurrection whenever an ample layer of fresh sand has accumulated.

Sample 67 represents the fresh mobile sand at the surface of the hillock. The salt content is relatively low (7.67%) with nearly equal amounts of sulphates and chlorides. The subsurface layer (sample 68) is a salt crust with salt content of 51.5%, mostly chlorides (23.45%). Then follows a layer with lesser salt content 28.5%. This is again followed by another salt pan layer (sample 70) where the salt content is 61.36%; again followed by a layer of reduced salinity (23.88%) then a third salt-pan layer (sample 72) where the soluble salt content is 49.19%. The bottom layer of this profile is the least saline (3.3%). It may be noted that the chloride content is the main variable among the salts, the sulphates vary but little. The organic carbon content is exceptionally higher in sample 69 which may indicate the remnants of previous plant growth. The relatively high estimates of the loss-on-ignition in some of the samples indicate the higher litter content.

Samples 60-62 and 63-66 are two profiles within quadrats 14 and 13. The former set represents the soil within and beneath the growth of *Arthrocnemon glaucum,* the latter represents the sterile ground in between the plant growth. In both sets, there is a surface crust of salt which is thin (0-2 cm.) within the plant growth profile and thicker (0-7 cm.) within the sterile ground. The salt content decreases rapidly in the sub surface layers. It is noted that the variation is much more notable in the chloride content than the sulphate content.

1.12 *Wadi Dib*

A transect comprising sixteen quadrats each 20×20 m. was laid across the main channel of Wadi Dib. It represents the extensive areas

TABLE 1

Analyses of soil samples collected from the various zones of the 14-quadrat transect of the Mallaha Locality, 8.2.1960

Remarks	Sample No.	Depth (cm)	Particle size mm (%)						Water soluble material (% oven dry weight)						% oven dry weight		
			> 2	0.5-2	0.2-0.5	0.1-0.2	0.07-0.1	< 0.07	Total	Cl	SO_4	NO_3	CO_3	Fe	Loss ignition	Organic C	HCl soluble
Mound of *Zygophyllum album* :																	
Soft salty sand	74	0-25	0.0	0.2	22.3	72.1	4.3	1.95	**11.37**	2.1	2.66	0.022	0.0	0.002	7.0	0.0	58.2
Soft salty sand	75	25-40	6.0	10.0	24.3	53.6	2.7	3.4	**10.8**	1.05	2.6	0.011	0.0	0.002	9.0	0.0	44.2
Hummock of *Suaeda monoica* :																	
Soft salty sand	76	0-60	0.7	0.9	24.4	70.6	2.4	1.0	**8.49**	1.9	1.74	0.022	0.0	0.002	8.5	0.0	40.8
Soft salty sand	77	60-125	0.5	9.0	32.7	52.9	2.9	1.7	**7.8**	0.38	1.69	0.011	0.0	0.002	1.5	0.0	47.8
Coarse sand mixed with salt	78	125-145	5.5	30.6	22.5	23.05	13.7	4.5	**11.2**	1.1	3.7	0.022	0.0	0.003	11.0	0.0	39.9
Coarse sand	79	145-185	16.5	58.8	15.3	5.6	1.2	2.5	**2.59**	0.42	0.96	0.011	0.0	0.002	3.0	0.0	15.3
Hillock of *Tamarix passerinoides*, quadrat 5 :																	
Sand	67	0-10	0.0	0.15	32.0	66.0	1.65	0.5	**7.67**	2.15	2.03	0.044	0.0	0.003	5.75	0.0	51.3
Organic matter + salt	68	10-20	0.0	7.2	27.6	47.7	4.6	12.6	**51.5**	23.45	4.53	0.066	0.0	0.008	15.5	1.3	76.9
Sand with salt	69	20-30	0.0	1.1	21.15	68.5	5.0	3.8	**28.5**	11.75	3.29	0.044	0.0	0.003	11.0	4.7	60.7
Salt crusts	70	30-35	0.0	2.5	30.45	47.05	7.45	12.4	**61.36**	30.05	2.47	0.044	0.0	0.002	9.0	0.0	77.9
Sand with salt	71	35-60	0.0	0.4	36.8	55.5	3.8	3.1	**23.88**	9.8	3.3	0.044	0.0	0.002	9.25	0.0	59.5
Salt crusts	72	60-65	0.0	3.0	34.7	48.8	6.8	6.3	**49.19**	25.1	2.27	0.044	0.0	0.002	7.5	0.0	72.06
Sand	73	65-100	0.0	0.4	22.6	71.1	3.2	2.4	**3.3**	0.8	1.2	0.033	0.0	0.003	7.75	0.0	47.2
Mound of *Arthrocnemon glaucum*, quadrat 14 :																	
Surface salt crust	60	0-2	0.0	1.3	88.7	0.0	4.1	5.6	**43.2**	19.3	4.5	0.011	0.0	0.002	39.6	0.0	70.5
Coarse sand roots	61	2-15	0.0	1.6	93.5	0.0	2.3	2.5	**3.3**	0.5	2.5	0.011	0.0	0.002	14.3	0.0	46.9
Sand	62	15-25	0.0	1.2	35.7	60.3	1.7	0.8	**3.6**	0.4	2.5	0.0	0.0	0.003	7.0	0.0	40.3
Ground between mounds of *Arthrocnemon glaucum*, quadrat 13':																	
Salt crust	63	0-7	0.0	0.2	37.75	60.55	3.85	2.25	**61.2**	30.45	5.4	0.0	0.0	0.002	8.6	0.0	82.9
Sand	64	7-17	0.0	0.55	36.85	60.75	1.35	0.35	**7.29**	2.3	2.7	0.011	0.0	0.002	18.5	0.0	44.5
Sand	65	17-27	0.0	18.1	0.1	75.4	5.7	5.7	**5.4**	1.4	2.06	0.011	0.0	0.003	15.75	0.0	42.2
Mud	66	27-40	0.0	0.9	29.5	59.3	7.2	7.2	**2.75**	1.1	0.94	0.0	0.0	0.003	8.2	0.0	43.4

of ground covered by the growth of *Haloxylon salicornicum*. The notable feature of this type of vegetation is the building up of sand hillocks around the plant growth. The hillocks range in size from little mounds to hills of considerable size : one hillock measures 225 sq.m. area and 6 m. height, see Pl. I, A.

TABLE 2

Analysis of sixteen quadrats (each 20 × 20 m.) set across the channel of Wadi Dib. The plant cover is a pure growth of *Haloxylon salicornicum*. The first figure = number of individuals, second figure = cover area in sq.m., x = areas less than one sq.m.

Quadrat No.	Haloxylon salicornicum
1	3-32
2	9-97.5
3	9-16
4	7-x
5	27-115
6	11-34
7	8-26
8	22-37
9	6-14.5
10	2-8.5
11	2-24
12	1-3
13	—
14	2-79
15	4-143
16	3-41.5

Table 2 gives the number of individuals and the area they cover in each quadrat. It is clear that this stand represents a pure growth of *Haloxylon salicornicum*. The plant builds sand hillocks that stand like isles amidst the gravel pavement of the floor. Quadrat 13 is barren. In the rest of the quadrats the number of individuals ranges from 1 to 27. The plant coverage varies irrespective of the number of individuals.

In quadrat 14 there are 2 hillocks covering 79 sq.m., in quadrat 15 there are 4 hillocks covering 143 sq.m. (individual = *c.* 40 sq.m.), in each of quadrats 1 and 16 there are 3 individuals covering 32 and 41.5 sq.m. respectively (individual = *c.* 10-14 sq.m.), in quadrat 4 there are 7 individuals with a total cover of less than 1 sq.m., (see also Fig. 3).

On the occasion of this survey (8.9.1960) there were no other species except *Haloxylon salicornicum* within the limits of the analysed transect. Within the whole area there were rare individuals of *Ochradenus baccatus.*

TABLE 3

Analysis of quadrats (each 20 × 20 m.) within the transect belt across Ghubbet El-Zeit littoral zone. Level (cm.) in relation to a zero point = sea water level at 10 a.m. on 9.9.60. For each species the first figure = number of individuals and the second figure = cover area in sq.m. x = areas less than one sq.m.

Quadrat No.	Level (cm.)	Halocnemon strobilaceum	Zygophyllum album	Suaeda monoica
	71			
1		8-238	2-5	—
	206			
2		11-220	5-2.4	—
	95			
3		7-5	11-3	—
	73			
4		—	11-3.5	—
	80			
5		—	19-9.5	1-1
	96			
6		—	33-27.5	—
	114			
7		—	35-22.5	—
	118			
8		—	50-20	1-5
	120			
9		—	17-8	1-9.5
	121			
10		—	9-14.5	—
	170			

(cont. Table 3)

Quadrat No.	Level (cm.)	Halocnemon strobilaceum	Zygophyllum album	Suaeda monoica
	170 m. unsurveyed			
11		—	5-2	1-3
	186			
12		—	2-x	6-8
	345			
13		—	7-2	5-6
	351			
14		—	—	3-6
	365			
15		—	—	2-5
	373			
16		—	—	2-8
	—			
17		—	—	2-1
	400			
18		—	—	3-2
	430			
19		—	—	3-6
	441			
20		—	—	2-5
	459			
21		—	—	—
	469			
22		—	—	2-2
	487			
23		—	—	1-x
	507			
24		—	—	1-2
	522			
25		—	—	3-11
	541			
26		—	—	1-7
	667			
27		—	—	—
	584			
28		—	—	1-6
	609			
29		—	—	—
	628			
30		—	—	1-4
	636			

Analysis of soil samples representing one of the *Haloxylon* hillocks shows that the main part of the sand belongs to the particle size range of 0.1-0.5 mm. (91%). The total soluble salt content is low (0.42-0.46%) including, especially in the surface sample, some nitrates (0.044%). The HCl soluble material is (lowc. 5%).

1.13 *Ghubbet El-Zeit*

A transect 800 m. long was laid across the littoral zone of the Ghubbet El-Zeit. The transect comprised a number of quadrats, each 20 × 20 m. The littoral ten quadrats were surveyed and charted followed by a gap of about 170 m., then an inland set of 20 quadrats that were surveyed. The ground level was measured in relation to a zero point which was the level of the sea water at 10 a.m. on 9.9.1960.

Table 3 presents the results of the analysis of the plant cover within the surveyed quadrats. It is clear that the vegetation is organized in three zones. The first is dominated by *Halocnemon strobilaceum*. This is a narrow zone fringing the shore line and is represented by the first two quadrats. In quadrat I there are eight individuals of *Halocnemon strobilaceum* covering 238 sq.m. (68% cover); in quadrat 2 there are eleven individuals covering 220 sq.m. (55% cover). Quadrat 3 includes seven individuals of *Halocnemon strobilaceum* measuring 5 sq.m. (1.2% cover), see Fig. 4.

It may also be noticed that quadrats 1 and 2 represent a littoral bar of high ground reaching the relative height of 206 cm. The ground level drops in quadrat 3 to the relative height of 73 cm. then it gradually rises inlandward, see Pl. I, B.

Quadrats 4-10 inclusive represent a zone dominated by *Zygophyllum album*, Pl. II, A. The number of individuals per quadrat ranges from 9 to 50 and the total area they cover ranges from 3.5 to 27.5 sq.m. With the exception of quadrat 9, which contains one individual of *Suaeda monoica* covering 9.5 sq.m., *Zygophyllum album* is the species with the greatest density. The plant builds small sandy mounds rising above the ground of the dry salt marsh.

Quadrats 11-13 represent a transition between the *Zygophyllum album* zone and the inland zone of *Suaeda monoica* (quadrats 14-30

TABLE 4

Analyses of soil samples collected from the various communities of Ghubbet El-Zeit locality, 9.9.1960

Remarks	Sample No.	Depth (cm)	Particle size mm (%)						Water soluble material (% oven dry weight)						% oven dry weight		
			> 2	0.5-2	0.2-0.5	0.1-0.2	0.07-0.1	< 0.07	Total	Cl	SO_4	NO_3	CO_3	Fe	Loss ignition	Organic C	HCl soluble
Mound of *Halocnemon strobilaceum* :																	
White moist salty sand.	157	0-10	0.5	15.1	54.6	26.0	2.5	1.3	**10.9**	5.85	tr.	0.033	0.0	0.0025	2.75	0.16	15.83
Dark yellow moist clay.	158	10.35	0.0	16.7	23.7	44.5	9.4	5.7	**16.5**	3.2	6.2	0.022	0.0	0.003	2.0	0.19	40.4
Loose coarse sand	159	35-50	36.0	27.3	23.5	9.4	1.6	2.2	**4.4**	0.45	0.1	0.066	0.0	0.002	2.25	0.1	9.0
Mound of *Zygophyllum album* :																	
Soft sand	160	0-10	2.1	10.6	22.0	58.4	5.8	1.1	**2.3**	0.89	tr.	0.033	0.0	0.001	2.0	0.08	11.71
Gravel with sand	161	10-40	35.9	25.1	26.5	10.7	1.5	0.5	**1.3**	0.33	0.41	0.022	0.0	0.001	0.75	0.0	10.99
As above but salty.	162	40-55	25.6	27.5	31.6	14.1	0.9	0.4	**3.34**	0.1	2.0	0.022	0.0	0.002	0.5	0.0	11.2
Same but moist	163	55-70	41.0	27.9	19.2	10.4	1.2	0.1	**2.18**	0.075	1.17	0.011	0.0	0.001	0.5	0.0	10.13
Hummock of *Suaeda monoica* :																	
Dry soft sand	165	0-25	3.7	31.0	38.4	22.6	3.4	1.0	**0.56**	0.16	0.0	0.011	0.0	0.0025	0.75	0.0	4.4
Sand mixed with gravel	166	25-48	40.0	21.8	25.6	11.6	1.1	0.4	**0.43**	0.25	0.0	0.011	0.0	0.002	0.5	0.0	4.4
As above but moist	167	48-58	27.3	22.3	25.0	20.1	2.8	2.5	**2.68**	0.9	0.45	0.0	0.0	0.0025	4.0	0.0	10.56

inclusive). *Suaeda monoica* builds sand hummocks of much greater size than those of *Zygophyllum album* and they are built on top of the desert gravel, see Pl. II, B.

Analyses of soil profiles representing the three main zones of the transect show that the soil salinity, as a whole, decreases inland. The littoral zone of *Halocnemon strobilaceum* is subject to inundation on the occasion of strong gales and the top of the sandy bar is no more than 2 m. above the level of the water table. The ground level in the rest of the zone is less than 1 m. above the water level. The *Zygophyllum album* zone represents phytogenic sand-mounds accumulated on top of the ground surface which is 120-170 cm. above the sea water level. The inland zone of *Suaeda monoica* is in fact the extension of the inland plain which is 3-6 m. above the sea-water level and on top of which are built the sand hummocks covered by the plant growth, see Table 4.

In the profile representing the *Halocnemon strobilaceum* zone (samples 157-159) the salt content is 10.9% in the top 10 cm. (mostly chlorides), 16.5% in the layer 10-35 cm. (mostly sulphates), and 4.4% in the bottom sample. In a profile representing the *Zygophyllum album* zone (samples 160-163) the salt content is 2.3% in the top 10 cm. (mostly chlorides), 1.3% in the layer 10-40 cm., 3.34% in the layer 40-55 cm. (mostly sulphates), and 2.18% in the bottom layer (mostly sulphates). In a profile representing one of the *Suaeda monoica* hummocks (samples 165-167) the salt content is 0.56% in the top 25 cm., 0.43% in the layer 25-30 cm., and 2.68% in the bottom layer representing the saline ground on top of which the sand has built the phytogenic hummock.

1.14 *Myos Hormos*

A transect was set across the littoral plain fringing the bay of *Myos Hormos,* an old Roman port. The transect comprises 20 quadrats each 20×20 m. Table 5 gives the results of the vegetational analysis of these quadrats and the ground level.

The terrestrial vegetation is organized into a shore-line zone of *Halocnemon strobilaceum* and an inland zone of *Nitraria retusa*. The former zone is here represented by quadrats 1-5 see Fig. 5. The number of individuals ranges from 8 to 17 and the total area they cover ranges

TABLE 5

Analysis of 20 quadrats (each 20 × 20 m.) set in *Myos Hormos* bay. Level (cm.) in relation to a zero point = sea water level at 4.30 p.m. on 10.9.1960. For each species the first figure = number of individuals, the second = cover area in sq.m.

Quadrat No.	Level (cm.).	Halocnemon Strobilaceum	Nitraria retusa
	0.0		
1		12-25	—
	52		
2		13-47.5	—
	50		
3		8-37	—
	57		
4		17-336.5	—
	126		
5		5-15.5	—
	138		
6		—	2-24
	137		
7		—	2-1
	161		
8		—	2-1
	182		
9		—	—
	148		
10		—	2-6
	164		
11		—	—
	208		
12		—	2-6
	222		
13		—	1-30
	220		
14		—	—
	257		
15		—	—
	249		
16		—	—
	223		
17		—	—
	209		
18		—	3-22.5
	193		
19		—	3-2.5
	207		
20		—	8-10
	206		

from 15.5 to 335.5 sq.m. per quadrat, that is, 4-85% cover, see Pl. III, A. There is an abrupt change in quadrat 6 where there is no *Halocnemon strobilaceum* growth. Quadrats 6-20 represent a zone of *Nitraria retusa*. The plant cover in this zone is very sporadic. Several quadrats are empty. The plant builds up hummocks of saline silt and sand. A hummock may reach 30 sq.m. in area, and 225 cm. in height (quadrat 13), see Pl. III, B. Further inland follows the desert plain where *Haloxylon salicornicum* is the dominant plant.

Within the bay of this area and fringing its shore-line there are a few individuals of *Avicennia marina*. This is the northward limit of this mangrove in the western Red Sea coast. We shall, in a later report, show that its growth increases southwards. Ferrar (1914) records *Avicennia* in the southern Qeisum island at the mouth of the Gulf of Suez, 40 km. to the northeast of *Myos Hormos*.

1.15 *Abu-Minqar Island*

This is a small coral island three km. to the southeast of the port of Hurghada. The island is cleft by a shallow creek. The plant cover comprises a few species and is organized into three types : the mangrove vegetation, the salt marsh vegetation and the high ground vegetation.

The mangrove vegetation is represented by thickets of *Avicennia marina* and is very well developed within the creek which traverses the island and in certain parts of the western coast of the island. The plant cover within the mangrove thickets ranges from 80-95%, see Pl. IV, A and B. A soil sample was taken from the mud below the *Avicennia* growth. The mechanical analysis of the sample shows its soft texture, including 18% of the fine particles (below 0.07 mm.). The total soluble salt content is 3.72% with obvious predominance of chloride (1.48) and little sulphate (0.22%). The HCl soluble material is 7.33% which is obviously low.

The mangrove thickets are fringed on the inland side by a zone of salt marsh vegetation dominated by *Arthrocnemon glaucum*. The width of this zone varies in obvious relation to the ground level : where there is a gradual inlandward rise in the ground level the zone is wide, see Pl. IV, A, whereas in places where the mangrove habitat is bounded by

low cliffs the *Arthrocnemon* zone may be absent, see Pl. IV, B, or very narrow. *Arthrocnemon glaucum* often forms pure growth with a total plant cover ranging from 60-80%. Rare individuals of *Zygophyllum album* may be present.

On the high ground, the plant growth is mostly a sparse population of *Zygophyllum album* and *Nitraria retusa,* and is confined to isolated localities where some soft deposits cover the underlying rock. The barren rock surface is usually sterile.

1.2 *The Littoral Marsh Community Types*

1.21 *The mangrove vegetation*

In the area extending from Zâfarâna to Hurghada the *Avicennia* mangrove vegetation is represented in two localities : *Myos Hormos* and Abu-Minqar Island. In the former locality there are a few depauperate individuals of *Avicennia marina.* This may represent a relic of a previous rich growth which has been destroyed, or may be a naturally poor growth. In Abu-Minqar Island the rich growth of the mangrove thicket is the most obvious feature of the otherwise featureless island.

1.22 Arthrocnemon glaucum *community*

The community dominated by *Arthrocnemon glaucum* usually fringes the shore-line. It often forms pure communities or may include individuals of *Halocnemon strobilaceum* and/or *Zygophyllum album.* The total plant cover varies from 20% to 100% according to the habitat condition especially the inlandward slope of the coast.

1.23 Halocnemon strobilaceum *community*

This community type is ecologically related to that of *Arthrocnemon glaucum,* both occupy the shore-line littoral. In the area extending from Hurghada to Zâfarâna and further north till Suez the *Halocnemon strobilaceum* community is much more widespread than that of the *Arthrocnemon glaucum* (see also Part I).

Halocnemon strobilaceum is the most abundant plant which contributes the main part of the vegetation cover, the plant cover ranges from 5 to 70%. Associate species include *Arthrocnemon glaucum* and *Nitraria retusa.*

Arthrocnemon glaucum is the most common associate but *Halocnemon strobilaceum* often forms pure stands covering sheets of tidal and/or chains of low sand dunes (see Pl. I, B and Pl. III, A).

1.24 Zygophyllum album *community*

The community type dominated by *Zygophyllum album* is one of the most common types within the littoral plain. The plant is obviously tolerant to salinity and is also capable of building phytogenic sand-mounds around its growth. It has the ability of producing adventitious roots from the parts of the shoot that may be covered by the accumulation of sand. These mounds may expand and coalesce forming sand sheets. Its habitat conditions range from the dry salt marsh flats to the non-saline sand mounds and sheets. The *Zygophyllum album* — dominated community occupies a zone transitional between the littoral *Halocnemon — Arthrocnemon* zone and the inland *Nitraria retusa* or *Suaeda monoica* zone. The plant cover may often form pure growth of *Zygophyllum album* or may be associated with scattered individuals of the species of the adjoining zones. In one locality the community includes *Halopeplis perfoliata* which is a rare species within the part of the Red Sea coast surveyed in this study.

1.25 Nitraria retusa *community*

This is one of the widespread community types within the salt marsh ecosystem. *Nitraria retusa* is a species which is also common within the wadis of the limestone desert to the west of the studied area. In these wadis the plant is mostly confined to silt terraces or salinized localities.

Within the coastal part of the surveyed area, the *Nitraria* community inhabits two types of habitat. The first is sandy bars that may develop on the shore-line rising to 150-200 cm. These sand bars are well represented in the area extending for 31 km. north of Ras Gharib and are actually chains of sandy hillocks, well covered by *Nitraria* growth, that expand and coalesce forming elongated bars. Associated with *Nitraria* there may be occasional individuals of *Tamarix mannifera.* To the seaward side a few individuals of *Halocnemon strobilaceum* may be found at the feet of these bars.

The second type of habitat is the saline mounds and hillocks which studd the dry salt marsh and which occupy the vegetational zone in between the salt marsh and the desert plain. We have already described this type in the transect across the area of Myos Hormos. It is notable that the *Nitraria* growth covers only the north-facing half of the mound whereas the rest is barren, see Pl. III, B. The ground between these mounds is usually sterile or may have few poorly developed individuals of *Nitraria retusa* or *Zygophyllum album*.

1.26 Suaeda monoica *community*

The community type dominated by *Suaeda monoica* is of a limited geographical distribution within the surveyed area. It is restricted within a stretch of about 135 km. extending from 20 km. to the north of Ras Gharib to 115 km. to its south. Further north of this stretch, this community type is not encountered, though occasional individuals of *Suaeda monoica* may be present within other community types.

Nitraria retusa and *Zygophyllum album* are the common associated species. *Tamarix mannifera* and *Haloxylon salicornicum* are rare associates. This community occupies a zone transitional between the *Haloxylon salicornicum* on the inland side and the typical salt marsh belt on the seaward side. In certain localities the *Suaeda monoica* community seems to replace the *Nitraria retusa* zone (see transect Ghubbet el-Zeit), but it extends inland much further than does the *Nitraria retusa* community. In several localities it grows on the gravel beds of the coastal plain.

1.27 *Other community types*

We group here four recognizable community types that are not common and the distribution of which is very limited.

(*a*) Tamarix passerinoides *community*

This is a community type apparently restricted in its distribution to the fringes of the inland salines. An example of it has been described in the transect of the Mallaha.

(*b*) Juncus arabicus *community*

Within the area of the present section this community type is confined to the drainage creeks of the inland salines. It is often associated with *Tamarix passerinoides*. *Juncus arabicus* chokes the channel of the creek whereas *Tamarix passerinoides* fringes its banks, see Pl. V, A.

(*c*) Salicornia fruticosa *community*

This is recorded from one part of the Mallaha which stretches to the south of Ras Gharib. There *Salicornia fruticosa* forms patches of pure growth with plant cover ranging from 50% to 100%. The ground is covered with a thick crust of salt. A sample of this crust was analysed. It had the following estimates : total water soluble salts = 80.05%, chlorides = 45.7%, sulphates = 7.3%, carbonates = traces.

(*d*) Halopeplis perfoliata *community*

This is recorded from the littoral marsh 50 km. south of Zâfarâna. Associate species include *Zygophyllum album* and *Suaeda monoica*. It may be noted that *Halopeplis perfoliata* is recorded as one of the most common species within the littoral salt marsh in the Red Sea coastal land of Sudan (Kassas, 1957), and we shall later show that it is common further southward.

1.3 *The Coastal Plain Community Types*

The desert coastal plain is the ground limited on the seaward side by the littoral salt marsh and on the inland side by the foot-hills of the Red Sea coastal ranges. The width of this belt varies as it depends on the local topography. Its seaward edge is often a few meters higher in level than the littoral zone. The ground is usually covered with rounded boulders and gravels (water-transported rock detritus). The coastal plain is dissected by shallow water runnels and by the deltaic parts of the main wadis. The plant growth is mostly confined to these drainage systems. The most abundant community type is dominated by *Haloxylon salicornicum*, the growth of which varies from depauperate individuals to huge sandy hillocks completely covered by its growth.

In the limited area extending from km. 53 to km. 55 north of Ras Gharib, the downstream parts of the drainage runnels dissecting the desert plain are occupied by a community type dominated by *Anabasis articulata*. In many localities within this limited area there are patches of rich growth of this plant.

There is a third recognizable (though rare) community dominated by *Capparis decidua*. Associated species include, *Launaea spinosa, Ochradenus baccatus, Pergularia tomentosa, Fagonia bruguieri* and *Taverniera aegyptiaca*.

2. Vegetation of Inland Country

2.1 *Wadi Milaha*

Wadi Milaha is a drainage system that deserves a special note. The upstream tributaries cut across the inland basement complex country. In its midpart it cuts across the Esh El-Milaha range. The downstream part spreads across the coastal gravel plain south of the Gemsa Bay. Within its midpart the wadi is fed by a brackish water spring (Bir El-Milaha) which forms a small sluggish stream with pools of saline water. The ground fringing the pools is generally incrusted with salt and is covered by dense plant growth of *Tamarix mannifera* and *Juncus arabicus*, associate species include *Aeluropus lagopoides*. On the drier peripheries *Zygophyllum coccineum* and a few other desert species may be present. Patches of semi-wild date-palm groves are also present.

Analysis of a soil profile from wadi El-Milaha shows the following. The surface three centimeters is a white salty crust, a mixture of coarse sand with 14.3% of gravel, water soluble material content = 22.8%. The salts are mixed chlorides and sulphates with traces of nitrates. Below this crust the soil is much coarser (gravel content = 30.5%) and less saline (5.5%). Further down the gravel content is reduced to 17.3% and the total water soluble material is 6%. In all the three samples the organic carbon is low though in the surface sample the loss-on-ignition ingredient is 7.75%.

Reference may be made to a detailed study of the soils of Wadi El-Milaha by Montasir (1938). He distinguished between the halophytic vegetation and the desert vegetation on grounds of soil and plant cover.

We may also refer to a comparable, though much smaller, wadi 35 km. to the south of Wadi El-Milaha, namely Wadi Abu Shar. This is a short wadi extending from the limestone block of Gebel Abu Shar El-Qibli and pours into the bay of *Myos Hormos*. In the upstream part of this wadi there is Bir Abu Shar around which there are patches of *Tamarix mannifera, Juncus arabicus* and *Phoenix dactylifera*. Away from these patches the vegetation is an open growth of *Zygophyllum coccineum, Zilla spinosa* with occasional bushes of *Acacia raddiana*. Associate species include : *Fagonia bruguieri, Trichodesma africanum, Lotus arabicus*, etc.

2.2 *Wadis of the Inland Plain*

(*a*) Acacia raddiana *scrub*

There is an extensive gravel plain separating the Esh El-Milaha range on the western side from the inland basement complex country. The main channels of the wadis traversing this low ground are characterized by extensive tracts of *Acacia raddiana* open scrubland, see Pl. V, B. Associate species include : *Artemisia judaica, Zilla spinosa, Aerva persica, Zygophyllum coccineum, Pergularia tomentosa, Capparis decidua, Calligonum comosum, Morettia philaena* etc.

The growth of this *Acacia raddiana* scrubland may be due to the combination of several factors. The organization of the drainage systems is such that it will cause the concentration of run-off water in the wadis : the channel of the wadis runs in between parallel ranges to the east and the west. The stratigraphical pattern is such that wadis are in geological lows, that is, these channels cut across deep valley-fill deposits where water may be stored. In other words shallowly seated underground water may be available as indicated by the few wells in the area. The third factor may be that the human population is thin in this rough country and hence the destruction is reduced.

(*b*) Salvadora persica *scrub*

The midpart of Wadi Bali which traverses the foot-hills of the inland mountain range is characterized by patches of *Salvadora persica*, see Pl. VI, A. Associate species that occupy the spaces between these patches

include *Zilla spinosa, Zygophyllum coccineum, Cleome droserifolia, Pulicaria undulata, Artemisia judaica,* etc.

2.3 *Wadis of the Montain Country*

Within the drainage systems of the mountain country represented here by the Shayib El-Banat-Qattar-Dukhan range, two main community types may be recognized. The first is dominated by *Zilla spinosa* and is widespread within the channels of the wadis. The second is characterized by the preponderence of *Moringa peregrina* and is confined to the upstream parts of the wadis draining the slopes of the higher mountain.

(*a*) Zilla spinosa *community*

Zilla spinosa is the most abundant species within the majority of the wadis, see Pl. VI, B and Pl. VII, A. This species acquires, in this district, a distinctly deciduous growth form. The shoot is dry and the plants may often be dead. In rainy years (e.g. 1960-1961), which are not of regular occurrence, new plants are profusely regenerated. It is suspected that *Zilla spinosa* is here a special variety [1] or a special ecotype (potential annual) and will require further detailed study.

Table 6 gives the floristic composition of ten stands representing the *Zilla spinosa* community type. All stands are localities in the wadis of the Qattar-Shayib range. The common perennial associates are : *Leptadenia pyrotechnica, Cleome droserifolia, Artemisia judaica, Fagonia mollis* and *Aerva persica*. Among the interesting perennial associates is : *Solenostemma argel*. In the inland (upstream) parts of Wadi Bali, *Zygophyllum coccineum* is a common associate of this community type, see Pl. VI, B. In certain localities *Calligonum comosum* is an abundant associate, see Pl. VII, A.

The district of mountains to the west of Hurghada was visited in February 1960, September 1960 and February 1961. In the first two visits ephemerals were not recorded within the wadis. In February 1961 there was a preponderance of ephemerals in certain localities (Umm Enab range). The most abundant species were : *Lotus arabicus*

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[1] *Zilla spinosa* v. *microcarpa* Dur. and Sch.

TABLE 6

Floristic composition of ten stands representing the *Zilla spinosa* community-type, within the Wadis of the Montain country. For each species the first figure is an abundance estimate according to a slightly modified Domin scale (+ — 10); the second figure indicates the aspect of growth : *g* = green (in foliage), *d* = dry (leafless, not dead), *fl.* = flowering, *fr.* = fruiting, *P* = presence.

Stand No.	1	2	3	4	5	6	7	8	9	10	P. %
Date	12.9.60	14.2.61	14.2.61	14.2.61	15.2.61	15.2.61	15.2.61	15.2.61	15.2.61	15.2.61	
Locality	Wadi Umm Sedrat	Wadi El-Ern	Wadi Umm Enab	Wadi Fatira	Bir El Atrash	Wadi El Ghata	Wadi Bali	Wadi Bali	Wadi El Owish	Wadi El Atrash	
Perennials :											
Zilla spinosa	5 d	5 d	5 d	5 d	5 d	4 d	4 d	5 d	4 d	4 d	100
Leptadenia pyrotechnica	—	2 d	—	2 g	1 g	2 g	2 g	—	3 g	4 g	70
Cleome droserifolia	1 g	1 g	3 g	1 g	—	—	1 g	1 g	—	—	60
Zygophyllum coccineum	4 g	—	—	—	—	+ g	+ g	3 g	—	3 g	50
Artemisia judaica	—	2 g	—	1 g	—	—	—	1 g	2 g	3 g	50
Moringa peregrina	2 g	1 g	—	—	—	—	+ g	+ g	—	—	40
Fagonia mollis	—	—	2 g	1 g	—	—	1 g	+ d	—	—	40
Acacia raddiana	—	—	—	—	+ g	3 g	2 g	—	—	—	30
Aerva persica	2 g	—	—	+ g	—	—	—	—	—	—	20
Trichodesma africanum	1 fr	2 fl	—	—	—	—	—	—	—	—	20
Pulicaria undulata	+ d	—	3 g	—	—	—	—	—	—	—	20
Lavandula stricta	2 g	—	—	—	—	—	—	—	—	—	10
Solenostemma argel	2 fl	—	—	—	—	—	—	—	—	—	10
Ziziphus spina-christi	+ fl	—	—	—	—	—	—	—	—	—	10
Pulicaria crispa	—	1 d	—	—	—	—	—	—	—	—	10
Capparis decidua	—	—	—	—	—	—	—	—	—	+ g	10
Colocynthis vulgaris	—	—	—	—	—	—	—	—	—	+ g	10
Ochradenus baccatus	—	—	—	—	—	—	—	—	—	2 g	10
Ficus pseudosycomorus	—	—	—	—	—	—	+ g	—	—	—	10
Calligonum comosum	—	—	—	2 g	—	—	—	—	—	—	10
Forskohlea tenacissima	—	—	+ g	—	—	—	—	—	—	—	10
Ephemerals :											
Lotus arabicus	—	2 g	2 g	—	—	—	—	—	—	—	20
Asphodelus fistulosus v. tenuifolius	—	—	4 g	—	—	—	—	—	—	—	10
Chrozophora plicata	—	2 g	—	—	—	—	—	—	—	—	10
Hyoscyamus boveanus	—	2 fl	—	—	—	—	—	—	—	—	10
Arnebia hispidissima	—	—	3 g	—	—	—	—	—	—	—	10
Aizoon canariense	—	—	1 g	—	—	—	—	—	—	—	10
Senecio flavus	—	—	2 g	—	—	—	—	—	—	—	10
Reichardia orientalis	—	—	1 g	—	—	—	—	—	—	—	10
Ifloga spicata	—	—	± g	—	—	—	—	—	—	—	10
Robbairea delileana	—	—	+ g	—	—	—	—	—	—	—	10

and *Asphodelus fistulosus* v. *tenuifolius*. Other ephemerals were *Arnebia hispidissima, Aizoon canariense, Senecio flavus, Reichardia orientalis, Ifloga spicata* and *Robbairea delileana* (usually perennial).

In certain localities of these wadis *Acacia raddiana* is locally dominant : patches of *Acacia* scrubland which are apparently relics of better growth that has been destroyed. *Acacia* scrubland is presumed to represent the natural climax vegetation of these wadis.

(*b*) Moringa peregrina *community :*

Moringa peregrina is one of the most interesting plants that are found within the mountain ranges of the Red Sea. The plant produces the behen-nuts (seeds) that are collected by the local natives and sold at a good price. These seeds produce the ben oil which is used for special lubrication purposes. This special attribute has obviously saved this bush : too valuable to be cut for fuel (Pl. VII, B).

The *Moringa* scrub is represented by patches that cover limited areas of the upstream runnels of the drainage systems. These are runnels collecting water at the feet of the higher mountains. A survey of the *Moringa peregrina* within the Red Sea mountains extending from Gebel Abu Dukhan (Lat. 27° 20′ N) to Gebel El-Farayid (Lat. 23° 30′ N) has shown that this species is confined to the feet of the mountains that are higher than 1300-1500 m. O.D. Lower mountains and hills have practically no *Moringa* at their feet.

Within the mountain range west of Hurghada the *Moringa peregrina* community type comprises the following shrubs (apart from the dominant) : *Acacia raddiana, Leptadenia pyrotechnica* and *Periploca aphylla*. Associate suffrutescent species include : *Zilla spinosa, Zygophyllum coccineum, Fagonia mollis, Artemisia judaica, Cleome droserifolia* and *Pulicaria crispa,* which are also common associates in the *Zilla spinosa* community type. Species of particular interest in this community type are : *Teucrium leucocladum, Lindenbergia sinaica, Chrozophora plicata, Capparis cartilaginea, Launaea spinosa, Lavandula stricta* and *Hyoscyamus boveanus*.

2.4 *The Nakkat Habitat*

Many of the higher mountains of the range under consideration, and indeed of the whole Red Sea mountains, have *nakkats*. A *nakkat* (arabic for water dropper) is a point from which water oozes and runs down the slope forming a tricklet that collects water in a pot-hole at the foot of the slope (*Bir*) or in some opportune hollow along the slope (*Gilt*). The source of the nakkat is often a fissure in the solid basement complex rocks of the mountain, usually situated near the top. The tricklet is the peculiar habitat of ferns (*Adiantum capillus-veneris*), mosses and algae; alien strangers of the desert environment. Associate species includes such water-loving plants as *Phragmites communis, Imperata cylindrica, Veronica beccabunga and Solanum nigrum.*

The *nakkat* habitat is also typical for *Ficus pseudosycomorus*. Stunted individuals of *Phoenix sp.* are in many *nakkat* seen hanging from the top or near the source. The wet areas that fringe or border the *birs* and *gilts* are often covered with rich growth of *Juncus arabicus, Cyperus laevigatus, Cynodon dactylon* and *Imperata cylindrica.*

The confinement of the *Moringa* growth to the feet of the higher mountains and the presence of these *nakkats* as features peculiar to such mountains seem to indicate the same thing, namely : the high altitude is a factor causing the collecting of added water.

DISCUSSION

1. General Characteristics

The ecological survey of the coastal-land stretch embodied in this and in the previous part I (Kassas and Zahran, 1962) shows the distinction between three major ecological belts (ecosystems) : the littoral salt marsh, the coastal plain, and the coastal ranges of hills and mountains. The whole complex is influenced — one way or the other — by the maritime conditions. The distinction between the three systems is a common experience in the studies of the Red Sea coastal land : Vesey-FitzGerald (1955, 1957, Saudi Arabia) Kassas (1957, Sudan), Hemming (1961, North Eritrea), Pichi-Sermolli (1955, Tropical East Africa).

Within the littoral salt marsh ecosystem the influence of the saline water of the sea is apparently the most marked ecological factor. The vegetation (and the habitat conditions) is organized into zones obviously 'proportionate to the concentration of (soluble) salts in the soil', Dansereau (1957, p. 211). The mangrove vegetation is here included in this ecosystem for convenience though it may better be included in the marine vegetation (salt water biocycle of Dansereau, 1957, p. 132-133). Other marine vegetation (Algae, *Halophila stipulacea, Gymodocea ciliata* etc.) are not dealt with in this study.

The vegetation of the coastal plain (desert) ecosystem comprises a mosaic pattern of plant community types obviously related to habitat conditions of water resources, landform and soil types. Within this ecosystem the desert environment is much more prevalent than the maritime environment. Except in localities with brackish (or saline) springs (or rills), the soil salinity is usually low.

The pattern of the plant cover of the inland hills and mountains is also influenced by conditions of landform. Notable here is the effect of higher mountains in intercepting some of the cloud (mist) moisture and hence creating conditions that are less arid.

Transects set within the littoral and the adjacent coastal belts (Transect AB, Part I, p. 142 ; Ghubbet El-Zeit Transect, this part, Table 3) show the distinction between the two systems. These transects also show that transitional zones are inhabited by *Nitraria retusa* community type or *Suaeda monoica* community type. The two dominant species of these two types seem to have a wide range of ecological amplitude that extends from the fringes of the salt marsh ecosystem to the border of the desert plain. It may be stated, in general terms, that the soluble salt content of the soils in the littoral salt marsh is substantial in amount especially in certain horizons, and that these salts are predominantly chlorides. The soluble salt content of the soils in the coastal plain is usually low, and the salts are mostly sulphates. With few exceptions, the plant cover in the littoral salt marsh is much denser (40-90%) than in the desert plain and the inland mountain country (5-40%).

The biotic influence of grazing and cutting is universal. Camels graze on the plant cover within the whole area from the mangrove in the sea

to the spinescent *Zilla* and *Acacia* vegetation of the mountain wadis. The goats and the wild ibex climb up the mountain slopes seeking plants. The sheep and the wild gazelles graze in the wadis and the plain.

The plant growth within the whole area is subject to intense climatic aridity : low rainfall and high rate of evaporation. The plants are able to inhabit the various types of inhospitable environment by virtue of their tolerance of these special conditions. There is obvious similarities in composition and structure between the vegetation of the littoral salt marsh and the inland saline localities : certain wadis across the east scarps of Galala El-Bahariya (Part I), Wadi Milaha (this part). This indicates that the common determining factor is the accumulation of salts.

2. The Littoral Salt Marsh

2.1 *General Remarks*

The littoral salt marsh ecosystem occupies a fringe bordering the shore line. Its inland extent is limited by the raised land : it may form extensive tracts or may be telescoped as where the high ground rises in the immediate adjacency of the shore-line (e.g. the eastern feet of Galala El-Bahariya).

The vegetation of the salt marsh ecosystem is characterized by simplicity of structure and composition. The plant cover is often formed of uniform growth of a single species; or a single dominant species and a few associates. Within the period of study (June 1959 —February 1962) seasonal aspects comprising the change in floristic composition due to the profuse growth of ephemerals were not observed. This notable character of the desert vegetation (Kassas, 1953 ; Oppenheimer, 1951 ; Negbi and Evenari, 1962 ; etc.) is not of the salt marsh vegetation of the arid climate.

« The student of maritime salt marsh cannot but observe that the vegetation changes as the marshes become higher and higher above the sea and hence less succeptibe to tidal inundation... and in many cases only a few inches increase in level results in a profound change... Such a zonation must imply that the vegetation on the salt marshes is seral in character and represents the salt marsh succession», Chapman

(1960, p. 9-10). Clear zonation related to ground level is undoubtedly a general character of the littoral salt marsh vegetation (this study; Kassas, 1957 ; Hemming, 1961 ; etc.). But the relation between the zones is not necessarily successional in a sequential order, as may be understood from Chapman's statement. The zonation is apparently related to the intensity of salinity. This does not show a pattern of regular successive change in relation to distance from the sea nor in relation to relative height of the ground. The middle ground which is subject to the least inundation by sea is usually much more saline than the seaward zones that are more frequently inundated and hence subject the washing of the salt crusts by the on-flowing and receding water. The ground which is aperiodically inundated and where water may be trapped between seaward sandy bars and the inland high ground is the most saline. The paucity of rainfall and the aridity of the climate are conditions that are superimposed on the local pattern of soil. A successional process caused, for instance, by the gradual accumulation of wind-borne sand (in the form of mounds, hillocks or sheets) will entail different (successional) phases of plant life within the different zones of the salt marsh. These different phases of plant life may be (but not always) comparable in floristic composition to the zones of the salt marsh vegetation. But this is due to the wide ecological amplitude of the limited number of the species that constitute the flora; and not to similar ecological conditions. This problem of differentiation between zonation and succession within the littoral salt marsh ecosystem will be dealt with in a future account which will report on an ecological survey of the whole Egyptian coast of the Red Sea. We may however, repeat what Chapman (1960, p. 12) states : « ... the succession on maritime salt marshes is not the simple sequence that earlier investigators have tended to describe».

2.2 *Vegetation Pattern*

We have described two salt-water community types, namely ; *Phragmites communis* reed swamp (Part I) and *Avicennia marina* mangrove (Pl. IV, A and B). The *Phragmites* reed swamp is represented in the estuary of Wadi El-Ghweibba where the drainage water may mix with the saline tidal water.

The mangrove vegetation is well represented in Abu Minqar island near Hurghada. Further north it is represented by a few depauperate individuals in the *Myos Hormos* bay. Further south there are extensive stretches of *Avicennia* and *Rhizophora* mangrove. « The presence of this formation (mangrove) depends chiefly upon the following : a muddy substratum... ; absence of frost, warmish water during summer; tide-erosion of insufficient power to uproot the young seedling» Cockayne (1958, p. 82). These conditions seem to obtain in the vicinity of Hurghada and to its south and not to its north.

Within the terrestrial salt marsh the zonation pattern depends on local conditions which may telescope or extend certain zones. The shore-line zone is the habitat of two closely related community types : one dominated by *Halocnemon strobilaceum* and the other dominated by *Arthrocnemon glaucum*. It is obvious that the former type is much more preponderant in the northern parts. South of Hurghada *Arthrocnemon glaucum* community type is the common type.

The inland margin of the salt marsh ecosystem is the habitat of two community types : one dominated by *Nitraria retusa,* and the other dominated by *Suaeda monoica*. The former type occupies this zone in the northern part extending from Suez to northern outskirts of Ras Gharib. In this part the *Suaeda monoica* community type is absent. The two types are well represented — though in alternate stretches — in the area from Ras Gharib to Hurghada. It will be shown in a future report that *Nitraria retusa* community type is less common within the coastal stretch south of Hurghada (up till Marsa el-Alam, lat. 25° 5′ N); further south *Nitraria retusa* community type is absent. It is not recorded in the survey of the Sudan Coastal Land (Kassas, 1957) where the *Suaeda monoica* community type covers extensive stretches.

The salt marsh ecosystem may comprise these two zones only, e.g. *Myos Hormos*. But usually there is an intermediate zone where a number of community types may exist. The most common type is that dominated by *Zygophyllum album*. It often occupies a zone next to the shore-line zone. The habitat of this community type may be saline flat ground, or may be such a ground covered with sand mounds built around the growth of *Zygophyllum album,* (see Pl. II, A).

The community type dominated by *Suaeda vermiculata* is represented in the northern part (Part I), otherwise it is rare. The community type dominated by *Limonium pruinosum* is of limited preponderance everywhere. The community type dominated by *Limonium axillare* deserves a special note. Within the area surveyed in this and in the previous paper (Part I), it is restricted to the small peninsula of Ras Adabiya, 15 km. to the south of Suez. Otherwise it is absent. But within the area extending southward from Marsa el-Alam (280 km. south of Hurghada) till the Egyptian border, this community type is one of the most abundant vegetational types of the littoral salt marsh. To this group of community types which occupy the intermediate zone of the marsh we may add a type dominated by *Cressa cretica* (in certain parts of the Zâfarâna district).

The salt marsh ecosystem is crossed by the deltas of the main drainage systems (wadis). This often causes the washing (seaward) of the salt marsh environment and hence bringing to the shore-line zone community types that do not belong to this ecosystem. The most notable example of this is the belt of the community type dominated by *Imperata cylindrica* in the delta of Wadi Hommath, see transect CD, Part I, p. 145. This community type belongs to the vegetation of the inland wadis with brackish springs.

In the area of Ain Sukhna (Part I), brackish springs have caused the establishment of an extensive sheet of *Juncus arabicus* growth within the littoral zone. This type of vegetation is also alien to the littoral salt marsh ecosystem. Like the *Imperata cylindrica* community type, the *Juncus arabicus* community type belongs to the vegetation of the inland wadis with brackish water springs (e.g. Wadi Milaha).

The community type dominated by *Tamarix mannifera* represents a salt marsh scrubland. Several patches of this type are found within the deltaic parts of wadis and in the Ain Sukhna area. The closely related scrubland dominated by *Tamarix passerinoides* is confined to the inland Mallaha to the south of Ras Gharib.

2.3 *Ecological Pattern*

The notable feature of the salt marsh habitat is the high content of water-soluble salts, mostly chlorides or/and sulphates. In the present

study it is noted that the soil salt content varies from one zone to the other and from one layer of the soil to the other. It is also noted that each vegetation type is associated with a wide range of soil salinity pattern. A few examples may be quoted.

(*a*) Table 4 gives the analyses of three soil profiles located within the three vegetational zones in the Ghubbet El-Zeit coastal belt. It will be noted that the first profile (shore-line zone of *Halocnemon strobilaceum*) has the highest salinity. In this profile maximum salinity is not in the surface 10 cm. (10.9%) but in the next layer 10-35 cm. (16.5%). Lower layers (below 35 cm.) have a reduced salt content : 4.4%.

The profile representing the intermediate zone of *Zygophyllum album* is much less saline than the previous one. In this profile the surface 10 cm. layer has a salt content of 2.3%, the next layer (10-40 cm.) has a lower content of 1.3%, this is followed by a layer (40-55 cm.) with maximum salinity of 3.34%, then the salinity is reduced down the profile.

The profile representing the inland zone of *Suaeda monoica* shows low salt content (0.56 and 0.43%) within the surface two layers (0-25 cm. and 25-48 cm.) and high salt content in the lower layer (2.68%).

(*b*) Analyses of soil profiles within the salt marsh of *Myos Hormos* show the following. The profile representing the *Halocnemon strobilaceum* growth is typical of the soil conditions of this shore-line zone. The ground surface is covered with a thin white salt crust not more than 1 cm. in depth. The salt content of this crust is 67.37%. The salinity is reduced within the surface 14 cm. to 5.8%. Lower layers (14-24 cm. and 24-40 cm.) have much reduced salt content (0.65% and 0.62% respectively). The profile representing the *Nitraria retusa* growth shows that the surface layers (0-8 cm. and 8-20 cm.) have high salt content : 26.15% and 22.45% respectively, and that the salinity is substantially reduced down the profile. It is also shown that the salinity is lowest (0.74%) in the submerged mud of the mangrove vegetation.

(*c*) Analyses of soil profiles representing the *Nitraria retusa* growth show a repeatedly observed phenomenon, namely the development of surface and subsurface layer of high salinity (salt pans). The salt contents

of the surface layers (0-5 cm. and 5-25 cm.) are 14.29% and 13.79%. The salinity is notably reduced within the lower layers reaching 2.28% in the layer 58-70 cm. This is followed by a layer (70-75 cm.) with high salt content (13.9%). Below this second salt pan the salt content is reduced to 1.68%. Another profile shows that the salinity is at its maximum (17.7%) within a layer between 20 and 25 cm. below the surface. Above and below this layer the salinity is very much reduced. In another profile it is noted that the maximum salinity (56%) is found within a thin pan, 25-27 cm. below the surface. Below this pan the salinity is reduced to 6.18% in the layer 30-45 cm. Further below the salinity varies but little around an average of 1.6%.

The general conclusions are :

(i) Within the shore-line zone the salinity is highest within a surface thin crust (e.g. *Myos Hormos*). The crust is probably ephemeral as it results from the drying up of the tidal water and will be washed by the next high tide. This is the situation within the shore-line flat ground. In localities where the shore line is fringed by sandy ribs (e.g. Ghubbet El-Zeit) the salt crust is much thicker and more permanent.

(ii) Within the inland zone of the salt marsh (*Nitraria* zone), the profile often includes two salt pans one at (or just below) the surface and the other is lower down. It is likely that the lower pan is primary in origin and is formed within the salt marsh flat ground; the upper is secondary and is formed after the building up of the surface deposits (mounds and sheets) around the plant growth.

(iii) The fresh (non-saline) sand forming the mounds as around the *Suaeda monoica* overlies the saline soil of the salt marsh.

(iv) It is repeatedly noted that the chlorides are the main salts within the shore-line zone and that the sulphates are more noticeable within the inland zone of the salt marsh.

(v) The root systems of the plants cross the whole profile but the main and the fine branches of the roots are confined to the less saline layers.

(vi) Zonation is a general aspect of the maritime salt marsh vegetation all over the world (Chapman, 1954; Oosting and Billings, 1942, etc.).

3. The Desert Plain

3.1 *General Remarks*

The desert plain ecosystem occupies the midland belt in between the maritime salt marsh and the inland range of hills and mountains. This plain is above the level, or far from the reach, of the tidal water. The habitat is usually non-saline but climatic and soil aridity is the main environmental feature. The plant growth is confined to the drainage systems where run-off water collects (run-off desert, Zohary, 1962).

Within the desert plain the soil transporting agencies (water and wind) are actively operating. The alluvial deposits range from fine silt to coarse gravel and boulders, and often build terraces on the sides of the water courses. The building and destruction of these terraces are physical processes that are mainly (not completely) independent of the plant growth. The aeolian deposits are sandy and build bodies ranging from small mounds to hills. These are often built around the plant growth (phytogenic), and their maximum size seems to depend on the species.

The vegetation of the desert plain shows a mosaic pattern and not a zonal pattern as noted in the salt marsh ecosystem. This may mean that the vegetational pattern is dependent on several interacting factors and not a single dominant factor. The vegetation shows distinct seasonal aspects mainly due to the preponderant growth of ephemerals during the late winter and early spring. This aspect of seasonal phenology is not noticed in the salt marsh.

The plant growth of the desert plain comprises a greater number of species. The floristic composition of the communities is usually much more elaborate than the simple composition of the salt marsh community type.

The coastal plain embraces, in certain parts, inland saline depressions represented in this study by the Mallaha south of Ras Gharib. The vegetation of these saline depressions belong (ecologically and floristically) to the salt marsh types. The same may be said about certain parts within the main wadis where brackish water springs form local saline habitats.

3.2 *Vegetation Pattern*

Within the desert plain ecosystem we have described several community types which may be grouped according to their general physiognomy into four categories.

3.21 *Desert Grassland Types*

This group comprises four community types. The first is dominated by a dwarf form of *Hyparrhenia hirta.* It is a rare type and is confined to some of the small rills dissecting the limestone erosion surfaces (see p. 141, Part I). The second is dominated by *Lasiurus hirsutus,* which inhabits the small runnels and tributaries of the drainage system. The bed is usually covered with discontinuous sheets of sand. This type is particularly common within the Wadi Araba drainage system. The *Panicum turgidum* and the *Pennisetum dichotomum* grassland types represent an advanced growth and inhabit the channels of larger tributaries. The two types are similar in structure, the two dominant grasses are tussock forming and are effective sand binders. The bed of the channels where such grassland types abound is usually covered with continuous sheets of soft material. The *Panicum turgidum* grassland type is associated with sandy deposits that are usually wind-borne. The *Pennisetum dichotomum* grassland type is associated with alluvial deposits derived from limestone detritus.

3.22 *Suffrutescent (woody) Types*

This group comprises five community types. The type dominated by *Artemisia judaica* is closely associated with the *Panicum turgidum* grassland type and is particularly common within the tributary channels of Wadi Araba where it dissects the sandstone formation. Outside Wadi Araba drainage system it is less commonly found within the area surveyed. (The species and the community types is widespread elsewhere, e.g. Sinai).

The community type dominated by *Iphiona mucronata* is confined to the limestone formations. It inhabits some of the minor tributaries where the bed is covered with coarse rock detritus and fragments. This community type is also widespread within the limestone desert extending from the Nile Valley to the Red Sea coast.

The community type dominated by *Cleome droserifolia* inhabits certain patches of the main channels of wadis dissecting the limestone plateau but does not extend to the coastal plain except in rare localities. The wadi bed (e.g. Wadi Aber, Wadi Moghra Part I) is covered with transported (rounded) boulders and gravels. The dominant species forms small cushions which collect limited amounts of soft material. This community type does not extend westward into the inland desert (Eastern Desert) and is confined to the coastal region.

The community types dominated by *Zilla spinosa* and *Launaea spinosa* are common within the main channels of wadis. They both abound on terraces with a mixed alluvium including soft material. The former type is widespread all over the Egyptian desert, but the latter is confined to the Red Sea coastal region.

3.23 *Suffrutescent (Succulent) Types*

This group comprises three main community types that are widespread all over the Egyptian deserts. The first is dominated by *Zygophyllum coccineum* and is — within the area surveyed — confined to the limestone country and to wadis with alluvial deposits that include limestone detritus.

The second is dominated by *Haloxylon salicornicum* which is the most common type within the parts of the wadis dissecting desert coastal plain. The floor of the parts of the wadis inhabited by *Haloxylon salicornicum* is usually covered with deep coarse (gravel) alluvial deposits. In certain localities, notably Wadi Dib (see Pl. I, A), *Haloxylon salicornicum* forms pure growth and builds sandy hummocks of considerable size. By contrast to the *Zygophyllum coccineum* community type, the *Haloxylon salicornicum* type is rarely found within the limestone country.

The third type in this group is the community type dominated by *Anabasis articulata*, a species which is morphologically similar to *Haloxylon salicornicum*. This type is confined to a few localities, namely : a part of Wadi Hommath (Part I) and parts of the coastal plain wadis between km. 50 and km. 55 north of Ras Gharib.

3.24 *Desert Scrubland Types*

This group includes four community types representing advanced stages in the vegetational and habitat development, and are confined to the main channels of wadis. The first is codominated by *Leptadenia pyrotechnica* and *Launaea spinosa* and is well represented on the silt terraces (see Pl. V, B, Part I). This community type is confined to the Red Sea coastal region and does not extend westward into the inland desert.

The second type is dominated by *Retama raetam*. It inhabits certain protected parts of the wadi terraces where the soil is a mixture of wind-borne sand and alluvial silt, (see Pl. IV, B, Part I).

The third type is dominated by *Tamarix aphylla* and is represented within the surveyed area by two forms. One form is a desert open 'forest' growth on silt terraces. This is represented by relic patches of trees, e.g. Wadi El-Ghweibba, (see Pl. VI, A, Part I). In this form *T. aphylla* acquires a tree form. The second form is well represented in the main channel of Wadi Araba where *T. aphylla* forms sand hillocks covered by thicket growth of this plant.

The fourth type is an open scrubland dominated by *Acacia raddiana*. This type represents the climax vegetation in the parts of the wadis where the surface beds of the valley-fill are gravelly. Whereas the *Tamarix aphylla* open forest represents the climax in the parts of the wadis with surface beds of silt. Comparable observation are recorded by Kassas (1957) on Khor Arbaat (Sudan) where *Acacia tortilis* dominates on areas of coarse sand and gravel and *Tamarix mannifera* on sheets of silt.

3.3 *Ecological Patterns*

The plant life in the desert plain, as in all desert habitats, is dependent on two main factors, namely; the water resources and the nature of the surface deposits (soil). Both are controlled by physical factors of topography. Small runnels that represent the distal (upstream) members

of the drainage systems have limited catchment areas and hence limited water resources. By contrast the main channels of the wadis receive drainage from extensive catchment basins. These main channels may be transformed into ephemeral gushing streams (desert torrents) moving considerable bodies of coarse sediments.

The beds of the various members of the drainage system are lined by surface deposits. The nature of these deposits influences the plant growth. In the words of Cannon (1913, p. 73) : « Given similar kinds of soil and equal precipitation, areas where there is greatest depth of soil will have the largest number of plants, and areas with light soil covering will have few or no plants. Also, having given sufficient soil, the kind of plants will depend on the soil depth. The special significance lies not so much in the differences in the soil *per se,* but in the differences in the water relation occasioned by variation in depth». This is explained by Kassas and Imam (1954). « The soil (surface deposits) is by far the most important feature. A thin soil will be moistened during the rainy season but will be dried by the approach of the dry season. A deep soil allows for the storage of some water in the subsoil. This will provide a continuous supply of moisture for the deeply seated roots of perennials».

The chemistry of the surface deposits seem to influence the composition of the vegetation. It has been shown that the *Panicum turgidum* grassland type abounds on sandy soils whereas the *Pennisetum dichotomum* grassland type abounds on calcareous soils. It was also shown that *Zygophyllum coccineum* community type is associated with limestone country whereas *Haloxylon salicornicum* community type is associated with sandy deposits.

Referring to the various community type recognized, we notice that certain communities are confined to smaller runnels which receive limited amounts of water. These include the *Hyparrhenia hirta* and the *Lasiurus hirsutus* grassland types, and the *Iphiona mucronata* community type. Other community types inhabit larger tributaries : *Panicum turgidum* and *Pennisetum dichotomum* grassland types, *Artemisia judaica* community type, *Zilla spinosa* community type, *Launaea spinosa* community type and *Cleome droserifolia* community type. The group of desert scrubland community types are confined to the main channels

of the greater drainage systems. It has been shown that these types are associated with different types (texture and composition) of wadi deposits.

4. The Mountains

4.1 *General Remarks*

The coastal chain of mountains included within the surveyed area (Parts I and II) comprises the predominantly limestone blocks of Ataqa, the Galala El-Bahariya and the Galala El-Qibliya and its southern extension ; and the chain of basement complex mountains bounded on the north by Gebel Gharib (1751 m. O.D.) and on the southern border of the surveyed area by the mass of Gebel Abu Dukhan (1662 m.), Gebel Qattar (1963 m.) and Gebel Shayib El-Banat (2184 m.).

The limestone blocks are table-like plateaus dissected by members of the drainage systems. The plant life is closely associated with the type of land form but is, with the exception of lichens, confined to the drainage runnels. For an enumeration of the land form types, which is in the meantime an enumeration of the habitat types, within the limestone country reference may be made to Davis (1951), Kassas (1953, b) and Girgis (1962).

The basement complex mountains are jagged masses of igneous rocks with peaks rising to 1700 m. O.D. and more. Gebel Shayib El-Banat (2184 m.) is the highest mountain in the Red Sea Coastal range of Egypt. The land form types are different from those of the limestone country : the slopes are dissected by shallow runnels with precipitously sloping channels, the beds of these channels are — as a rule — covered by massive blocks and boulders. These runnels debouch into the drainage lines at the feet of the mountains.

A notable difference between the limestone plateau and the basement complex mountains is this : the water resources available for plants in the former type is mainly the run-off water of the convectionnal rainfall, that in the latter type comprise also orographic condensation of cloud moisture. This difference causes the pattern of the plant life within the limestone plateau country to be such that the lower the level of the habitat the less arid it is as it receives greater proportion of drainage.

This is not necessarily the case within the jagged mountains of the basement complex : high up the mountain the plant growth may indicate habitat conditions less arid than that indicated lower down the slope. Reference may be made in this respect to the ecological studies on the Red Sea mountains of Sudan by Troll (1936) and Kassas (1956, 1960).

4.2 *Vegetation Pattern*

Within the limestone masses, the plant life on the slopes, cliffs, dry water falls that intercept the courses or runnels are the habitat of a few characteristic species : *Capparis spinosa, Ficus pseudosycomorus,* and less commonly *Capparis cartilaginea.* Associated with these are other species that may also be found within the finer runnels of the drainage system e.g. *Telephium sphaerospermum, Salsola tetrandra* (on Cretaceous limestone), *Halogeton alopecuroides, Helianthemum kahiricum, Echinops galalensis, Ephedra alte, Erodium glaucophyllum, Hyparrhenia hirta, Stachys aegyptiaca, Reaumuria hirtella, Forskohlea tenacissima* and *Fagonia mollis.* All may grow as chasmophytes.

Within the basement complex country, three community types are recognized within the wadis occupying the valleys between the mountain blocks. The *Salvadora persica* community type is represented by patches of almost pure growth within the channels of the main wadis. The *Zilla spinosa* community type is widespread. Within the habitat of this type there are certain patches of relic *Acacia raddiana* scrub. The third type is the *Moringa peregrina* community type which is confined to the feet of the mountains rising to 1500 m. and more. Lesser mountains have no *Moringa* scrub at their feet.

The special habitat type of the *Nakkat* is confined to the higher peaks and is associated with types of vegetation that are non-xerophytic (ferns, mosses, algae, *Phragmites communis,* etc.).

The plant growth within the mountain area shows remarkable seasonal and annual fluctuations. The notable aspects of these fluctuations are primarily due to the growth of ephemerals. They appear in the late winter and early spring in profuse numbers of individuals e.g. February

1961. Yet in years of low rainfall (1959-1960) ephemerals may not appear except around wells and nakkat rills.

4.3 *Ecological Pattern*

The cliffs and slopes of the sedimentary formations provide special habitat conditions in which special plants may grow. These chasmophytes are probably isolated individuals that do not form communities in the sociological sense. They often grow in places inaccessible to grazing animals and this may explain the fact that some of these species are confined to this particular habitat, e.g. *Ficus pseudosycomorus.*

The *Salvadora persica* growth within certain parts of the main wadis of the southern mountains reminds us with the comparable but more extensive growth of the Sudan (Kassas, 1957). The growth form of this species may be a tree or a cushion like patch of short branches. This latter form may be the result of repeated cutting, *Salvadora* is the toothbrush tree of the Orient.

The growth of *Moringa peregrina* and the formation of the *Nakkat* habitat are confined to higher mountains of the Red Sea coast. This means that higher mountains (above 1500 m. O.D.) cause the interception of added amounts of moisture. The orographic condensation of moisture by mountains is a universal phenomenon, especially in coastal country. It is suggested that the prevalent dry northerlies absorb, as they pass over the water mass of the Red Sea, certain amounts of moisture. As they cross the coast they impinge upon the higher mountains and orographic precipitation of their moisture results. Some of this moisture runs off the « glazed» slopes of granites and other impervious igneous rocks and accumulates at the feet where *Moringa peregrina* is confined. Some of this moisture is trapped in crevices and may accumulate in storage cavities from which it oozes forming the *Nakkats.*

The higher parts of the mountains are the habitat of certain species that are rare in the surveyed area (e.g. *Rhus oxyacantha*). It is suggested that such plants may also be able to exploit directly the moisture of the clouds (mist of the mountains).

It is to be noted that the mountains north of Hurghada (Gebel Gharib, 1751 m.) do not enjoy this orographic source of moisture. This may be

due to the fact that they face a narrow mass of water of the Gulf of Suez and not the full stretch of the Red Sea. Hurghada lies at the entrance of the Gulf. We may add that mountains south of Hurghada show signs of greater moisture revenue and their slopes, especially the higher parts, are the habitat of a great variety of species that are otherwise rare or absent.

Before ending this discussion it may be said that the phytosociological consideration of the plant communities referred to in this study is deferred to a future study which will include the whole stretch of the Red Sea coastal land of Egypt.

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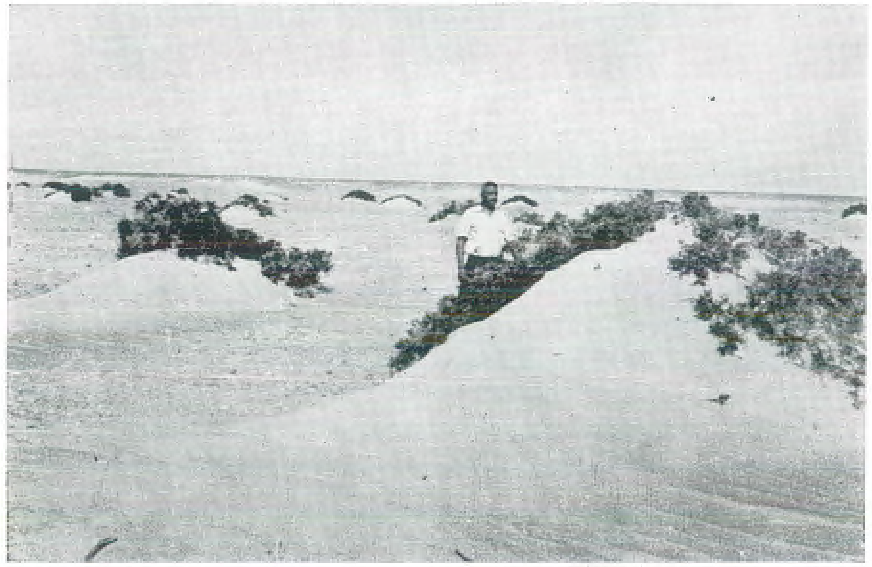
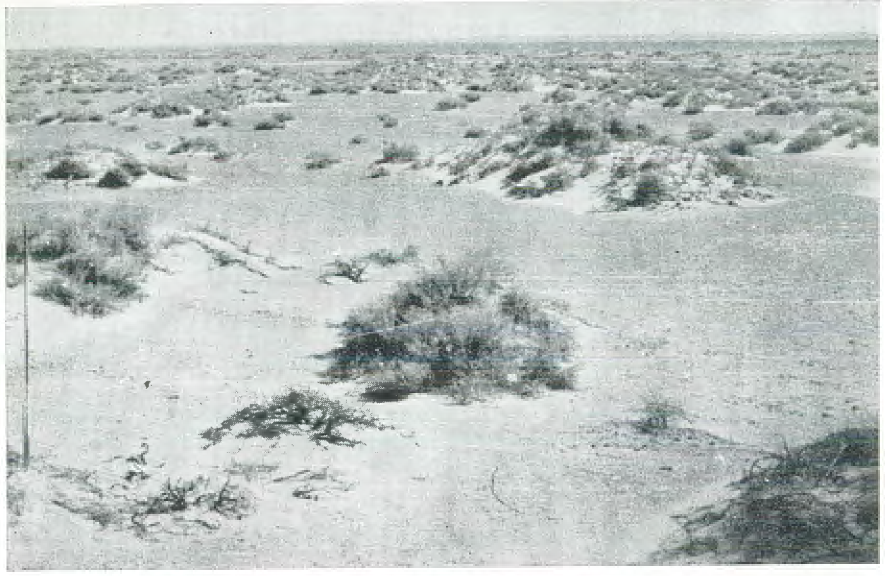
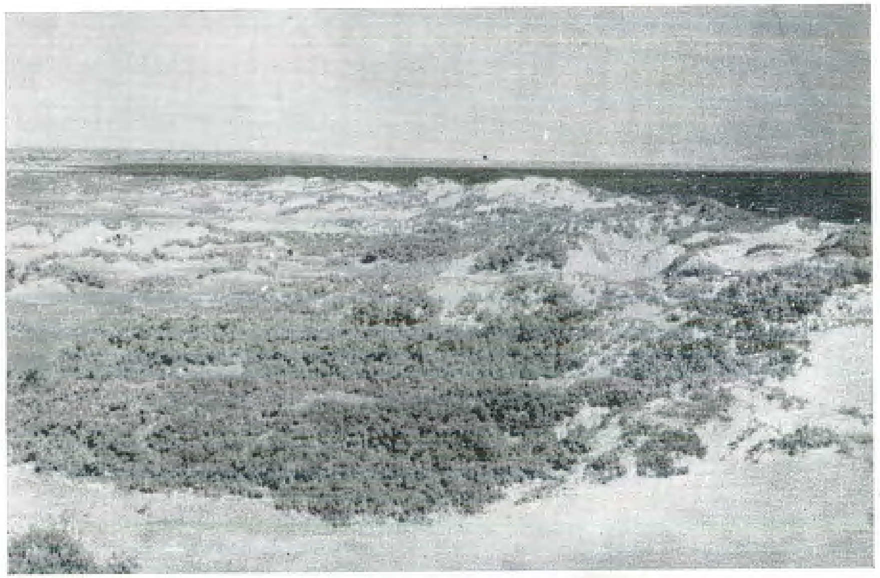
A. — General view of the gravel coastal plain of Wadi Dib area showing the sand hillocks covered with, and built around, the growth of *Haloxylon salicornicum*, (September 1960).



B. — Littoral sand bar fringing the shore line (the sea is shown in the mid-part of the photograph) in Ghubbet-El-Zeit bay showing the *Halocnemon strobilaceum* zone of the transect described in the text (September 1960).

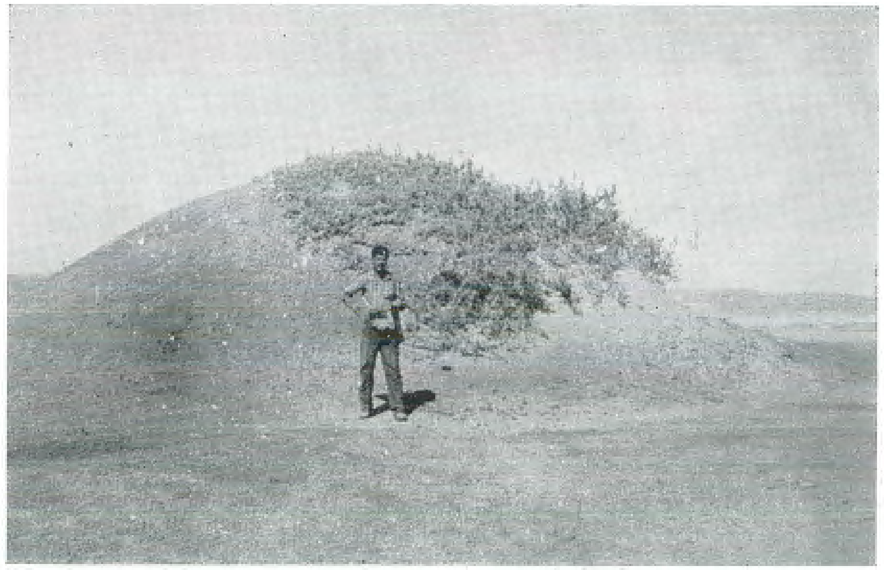


A. — Ghubbet-El-Zeit, general view of the *Zygophyllum album* zone of the transect described in the text. Note the *Suaeda monoica* (Darker colour) in the background, and the small sand mounds built around the *Zygophyllum album* growth (September 1960).

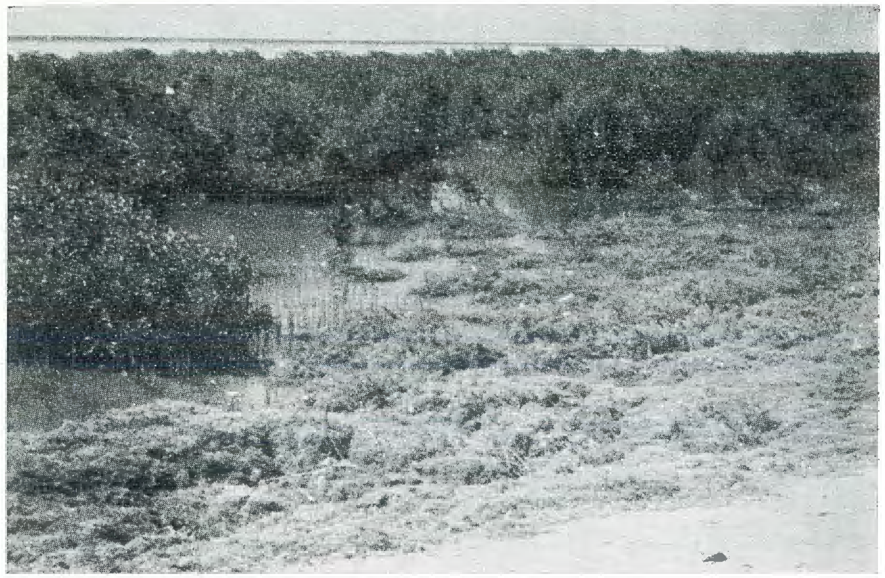


B. — Ghubbet-El-Zeit, the zone of *Suaeda monoica* in the transect described. Note the size of the mounds (September 1960).

A. — View of the *Halocnemon strobilaceum* growth on the tidal mud of the bay of *Myos Hormos* (20 km. north of Hurghada). Note the circular patches of the plant growth (September 1960).



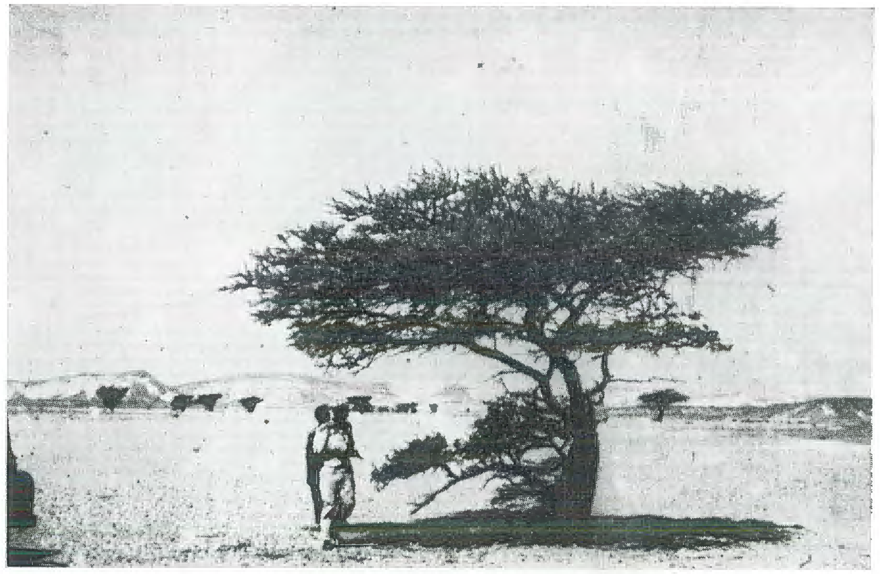
B. — A close up view of a *Nitraria retusa* hillock. The surface of the hillock is half-covered with *Nitraria* growth, *Myos Hormos* (September 1960).



A. — View of the central channel of the Abu-Minqar island (offshore Hurghada). Note the *Arthrocnemon glaucum* in the foreground and the *Avicennia marina* in the creek (September 1960).

B. — Mangrove (*Avicennia marina*) growth in Abu Minqar island. The channel is here bounded by raised beach that bears no littoral vegetation as contrasted to the shore-line zone of *Arthrocnemon glaucum* shown in Pl. IV, A, (September 1960).

A. — A view of one of the drainage creeks of the inland Mallaha (south of Ras Gharib). The creek is choked by the growth of *Juncus arabicus*. Note the bushes of *Nitraria* and *Tamarix* on the sides of the creek (September 1960).

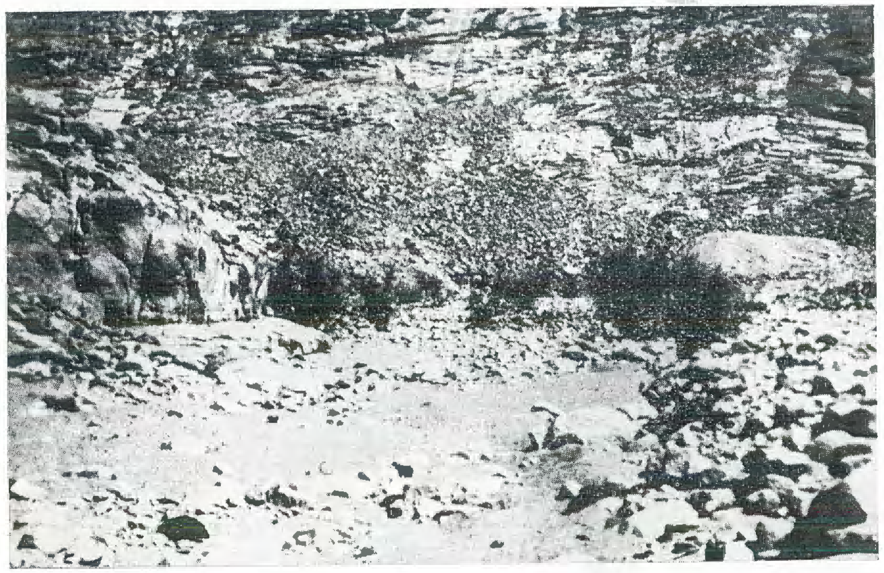


B. — General view of Wadi Abu Hadd, *Acacia raddiana* open scrub. Note the limestone ridge in the background (September 1960).

A. — General view of part of Wadi Bali showing patches of *Salvadora persica* growth. Note the jagged mountains of the Gebel Shâyib El-Banât range (September 1960).

B. — A view of the upstream part of Wadi Bali. Note the growth of *Zilla spinosa* and *Zygophyllum coccineum* in the channel of the wadi and *Moringa peregrina* on the sides at the feet of the mountains (February 1961).

A. — A view of Wadi Ghuzzi on the west side of the Gebel Shâyib El-Banât range. The plant growth is dominated by *Zilla spinosa* and *Calligonum comosum* (February 1961).



B. — A typical view of the growth of *Moringa peregrina* at the feet of high mountains, Gebel Qattar. Note the coarse boulders that cover the bed of the wadi and rolling down the slope (September 1960).

DAMRÛÂ (GHARBIYAH): PAST AND PRESENT

BY

OTTO F.A. MEINARDUS

For almost one hundred years, *i.e.* from 975 A.D. to about 1061 A.D., Damrûâ served as the cell or the residence of the Coptic Patriarchs, and as such, the name of this village is mentioned sixteen times in the History of the Patriarchs of the Egyptian Church by Sawîrus ibn al-Mukaffa [1]. Up to the middle of the VIth century, the Coptic Patriarchs resided in Alexandria, but on account of Byzantine pressure, the official residence of the Patriarchs was moved to the Dair Abû Maqâr in the Wâdî 'n-Natrûn. However, several Patriarchs, whenever it seemed feasable, as in the days of Anastasius (605-616 A.D.), returned to Alexandria. By the VIIIth century, the official residence was again in Alexandria, though the Patriarchs spent a great deal of their time in Cairo.

It was in the days of al-ʿAzîz (975-996 A.D.), that Macarius (Makârah), the secretary of the Synod, advised Philotheus (Filatâwus), the 63rd Patriarch of the See of Alexandria (973-1003), to move the patriarchal residence to Damrûâ, where Menas (Mînâ), the Bishop of Tânah and the brother of Macarius, was living. Apparently, Bishop Menas had a « good dwelling-place » at Damrûâ, which made it attractive for the Patriarch to accept the suggestion of the Synod's secretary [2]. Philotheus also consecrated a certain John Bishop of Damrûâ [3]. The patriarchal

[1] *The History of the Patriarchs of the Egyptian Church* (*HPEC*), II,ii, II,iii, transl. ʿAziz Suryal Atiya, Yassa ʿAbd al-Masih, O.H.E. KHS-Burmester, Cairo, 1948, 1959. 151, 170, 178, 225, 226, 228, 239, 261, 264, 267, 268, 269, 275, 297.

[2] *HPEC*, II,ii, 151.

[3] The bishopric of Damrûâ could have existed only for a very short time, for it is not accounted for in the list of dioceses of 1078 A.D. Munier, H., *Recueil des Listes Episcopales de l'Eglise Copte*. Cairo, 1943, 26.

quarters must have been quite extensive, for the Patriarch used to receive and entertain there certain people of the inhabitants of Damrûâ, as well as the members of his family and his near relatives, whose usual custom it was to sit and to drink with him [1].

In 1003 A.D., Philotheus died and Zacharias (Zakhâryâs) ascended the patriarchal throne (1004-1032). Zacharias also took up his residence in the patriarchal cell at Damrûâ, where he was frequently visited by bishops, priests, monks and laymen. Among other visitors, he received at Damrûâ Mercurius (Markûrah), Bishop of Tilbanâh, who suffered from leprosy [2], he pardoned the deacon of Minyatî Milîg, a repentant homosexual offender [3], and he also received the blessing of Sisîh, the Nubian monk, with whom he was imprisoned and with whom he was cast to the lions [4]. Moreover, Zacharias built the « Great Church » at Damrûâ, *i.e.* the patriarchal cathedral. Thus, Damrûâ rose rapidly in importance and seems to have been inhabited entirely by Christians, and, being at some distance from any seat of the Muslim Government, it may have escaped notice for some years [5].

Zacharias was succeeded by Shenute II (Shanûdah), the 65th Patriarch of the See of Alexandria, who reigned from 1032-1046. Following the practice of his immediate predecessors, Shenute II also resided at Damrûâ and completed the building of the « Great Church » [6]. At this time, Damrûâ was well known, for even prior to his election to the patriarchate, Shenute II had vowed to spend much money on the completion of the patriarchal cathedral. Shenute II died in Damrûâ, and was buried in the « Great Church ».

The fourth and the last Patriarch to reside at Damrûâ was Christodoulus (Akhristûdulû), the 66th Patriarch (1047-1077). During his patriarchate, Damrûâ increased even more in importance and also in size, so that it was known as the « Second Constantinople » with seventeen

(1) *HPEC,* II,ii, 170.
(2) *HPEC,* II,ii, 225.
(3) *HPEC,* II,ii, 226.
(4) *HPEC,* II,ii, 228.
(5) Butcher, E.L., *The Story of the Church of Egypt.* London, 1897, vol. II, 43.
(6) *HPEC,* II,ii, 239.

churches, most of which were restored [1]. During this period, Peter (Butrus) the Anchorite once celebrated the Divine Liturgy in the Church of Damrûâ Khammârah, and when he placed his finger on the rim of the chalice and offered the prayer of the epiclesis, the chalice flowed so that it was filled to its edge and his finger was dyed [2]. Christodoulus also built in Damrûâ a new patriarchal residence, and over its door he had engraved the Trinitarian Formula : « In the Name of the Father and of the Son and of the Holy Spirit ». Abû'l-Husain ʿAbd al-Wahhâb ibn ʿAlî as-Sinrâkî, the kâdî, went to meet Christodoulus in Damrûâ, and when he read the words engraved over the entrance of the door, he complained to al-Yazûrî, the wazîr. The wazîr ordered the churches to be closed and the Trinitarian Formula to be erased from the patriarchal residence [3]. Trouble between the Patriarch and the Sultan led to the arrest of Christodoulus, and they found in his dwelling-place in Damrûâ a basin in which there were six thousand dînârs tied up in a red cloak. The money was confiscated and taken to the Treasury and Christodoulus returned to Damrûâ [4].

In the latter part of the reign of Christodoulus, some forty thousand horsemen besides their attendants of the Lewatis invaded the Nile Delta and went to Damrûâ and took the Patriarch from his dwelling-place and plundered all that was in it, and took very much money which he had [5]. The Patriarch then took temporary refuge in Alexandria and subsequently transferred the patriarchal residence to Cairo. Most, if not all of the churches and the patriarchal residence, which, at that time, would have been built with burnt-bricks and mud-bricks, were destroyed. Those buildings, which survived the devastations of the Lewatis, were probably destroyed by the Ghuzz, who, during the patriarchate of Cyril II (Kîrillus) *i.e.* 1078-1092, took possession of the Province of Gharbiyah. [6]

(1) *HPEC,* II,ii, 268.
(2) *HPEC,* II,iii, 297.
(3) *HPEC,* II,iii, 268.
(4) *HPEC,* II,iii, 275.
(5) *HPEC,* II,iii, 279, 314.
(6) *HPEC,* II,iii, 344.

* * *

Some questions have been raised as to the topographical identity of the patriarchal cell of Damrûâ, since there are several villages in the Nile Delta, which are called Damrûâ. The first reference to Damrûâ or Tiemrô is in the Acts of Didymus of Tarshebi, where mention is made of a certain Raklida, the priest of Tiemrô [1]. The name Tiemrô, which means « harbour», however, suggests, that this town was situated at a lake (Burullus ?) [2]. Quatremère identifies Tiemrô with the locality of Damrûâ, which is mentioned in the *History of the Patriarchs of the Egyptian Church* [3]. On the other hand, Neale wrongly identified Damrûâ with Damanhûr or the ancient Hermopolis Parva [4]. Moreover, northeast of Disûq, there is the village of Damrûâ Salman, which is mentioned in the *État de l'Égypte* as Damrou al-Muhallah Sulaiman, and which extends over 593 feddan [5], but this village cannot be the patriarchal cell, for the Patriarch Zacharias is reported to have gone walking without a beast to Tumbârah, a village, which is situated 2 km. north of Damrûâ Khammârah.

The present Damrûâ comprises the three villages of Kafr Damrûâ, Shubra Nabât or Shubra Damrûâ and Damrûâ Khammârah, which are situated 17 km. north of al-Mahalla al-Kubra and 21 km. west of al-Mansûra in the Province of al-Gharbiyah. These three villages, of which Kafr Damrûâ is the southernmost, appear as a single unit without any visible boundaries. These villages extend over 3,463 feddan, 12 karat, *i.e.* Kafr Damrûâ with 765 feddan, 9 karat, 12 sahm; Shubra Nabât with 916 feddan, 6 karat, 16 sahm; and Damrûâ Khammârah with 1,780 feddan, 9 karat, 8 sahm [6]. The population of these three villages

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[1] Hyvernat, H., *Actes des martyrs de l'Egypte.* Paris, 1886, 302.

[2] Amélineau, E., *La Géographie de l'Egypte à l'Epoque Copte.* Paris, 1893, 505. Champollion, M., *L'Egypte sous les Pharaons.* Paris, 1814, vol. II, 232.

[3] Quatremère, Et., *Mémoires hist. et géogr. etc.* Paris, 1811, vol. I, 358.

[4] Neale, J.M., *A History of the Holy Eastern Church.* London, 1847, vol. II, 217.

[5] De Sacy, S., *Relation de l'Egypte.* Paris, 1010, 632.

[6] *Mémoires de la Société Royale de Géographie d'Egypte.* Cairo, 1963, vol. VIII,iii, 455.

is entirely Muslim, except for the Coptic pharmacist in Kafr Damrûâ, who has recently come from al-Mansûra.

Within these three villages, there are no archaeological or architectural traces of churches. There are three mosques, the Mosque of Sidi Muhammad Abû'l-Ruûs and the New Mosque or the Great Mosque, which serves the people of Shubra Damrûâ and Kafr Damrûâ, and the Mosque of Muhammad ad-Damrî ibn Sâlih, which was built in the XVIIIth century and which is situated in Damrûâ Khammârah.

Approximately 300 metres north of the limit of the village of Damrûâ Khammârah, there is the Muslim cemetery situated on a slight elevation (kôm). Many of the tombs are built with burnt-bricks, and the villagers maintain that the bricks belonged to « the ancient baths which were the property of a king». Indeed, 100 metres north of the cemetery are the remains of a burnt-brick building, which is identified with *kôm al-hammâm,* and this site supposedly belonged to the Christians. The area in question, which occupies 6,50 m. by 10 m. is enclosed by a wall of burnt-bricks of 0,80 m. thickness and projects from the ground 0,50 m. The village-elders knew of altogether four baths, which were supplied with water from a nearby well, which is now covered. This may have been the bathing place, which is referred to in the History of the Patriarchs [1].

The space between the Muslim cemetery and the baths was described as the site of the Christian cemetery, though it did not contain any tombs or any other indications to substantiate the tradition. It appears, that by the XIIth or XIIIth century the population of Damrûâ had become Islamic, and, therefore, it is not surprising, that so little is remembered of the time, when Damrûâ served as the patriarchal residence.

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[1] *HPEC,* II,ii, 170.

The Ruins of the «Baths» of Damrûâ.

STRUCTURAL FEATURES
OF GEBEL-EL-MOKATTAM AREA, E. CAIRO

BY

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SUMMARY

Egypt consists morphologically of the « Eastern Desert» with a strong morphological accentuation and the « Western Desert» with a low relief. The area investigated in this paper is situated on the border between the two different units.

Egypt displays geologically in its younger formation area two types of tectonics. A slightly folded belt the so called « Syrian arcs» in the North and the practically undisturbed areas further South. The Syrian are itself or rather its complex is interrupted by a gap occupying the region between the Gulf of Suez area and Abu Rawash area West of the Nile. In this gap faulting and fractures exceeds folding and besides a peculiar volcanic evolution took place. Where this « gap» ends in the West, the Mokattam area is situated.

So, in our area, the folding tectonics proper are absent and are replaced by typical fracture systems. This difference is theoretically or better hypothetically explained by a difference in the geological composition of the area with its wider vicinity as well as the presence of a thinner sedimentary cover or blanket.

In the folding regions of the Syrian arcs, located on both sides of our area, the author assumes that they are covered by a relatively much thicker blanket. Further, this thinner sedimentary cover in the above mentioned gap might be due to a continuation of the Eastern Desert basement « spur» towards the N.W., in the subsurface leaving a shallow sedimentary blanket of young formations above, that were easily fractured.

Even, the Delta itself might be nothing but a West displaced portion of the Gulf of Suez, probably mechanically created as a result of the same hypothesis, i.e. the NN.W. extension of the basement spur in the deeper depths.

Intimate microstructural investigations together with an evaluation of the structures in the wider vicinity show a field of extensive tension compensated mostly by antithetic step faults, little grabens, block-tilting and likewise. Moreover the close study in our area shows that there are two main trends of these step-faults and fractures, namely a NW-SE higher order set and an E-W second order set. These two systems belong to one mechanical system corresponding to the two main D-joint-systems developed in anticlines with mainly competent beds.

It is assumed that the development of these fracture systems is directly replacing in space and in time, the actual folding which took place in the Western Desert simultaneously. So, our fractures and step-faults originated during late Eocene or directly after. Later they have been revived several times, e.g. in Oligocene, Miocene and probably even at a later period.

The present work reveals the fact that there is a typical structural style-change along the Nile Valley. In this respect, the author recorded that the Nile Valley in the region between our area at its E. and the Giza pyramids area at its W., is actually a shallow graben; a portion of the so called « Maadi Graben ». This fact is merely local, as this graben strikes NW-SE, i.e. having a different strike to that of the Nile. To the west of our area, the river Nile crosses the Maadi graben obliquely.

I. — REGION AND PROBLEM.

The area discussed in the following pages can be looked upon from different points of view, as it offers especially morphological, stratigraphical and tectonical aspects. Regionally its center-portion is the conspicuous scarp overlooking the city of Cairo on its eastern side. It starts from Gebel-el-Ahmar in the NE, extends in a south-westerly direction, includes the citadel and then takes a bend to the south-east and ends to the east of Maadi (key map 1). This area and its natural surroundings are dealt with below with respect to their major and minor structural elements, in order to get a dynamic correlation with adjoining areas.

The aim of this investigation is :

(*a*) to record the stratigraphical and structural data so far available.

(*b*) to attempt a synthesis of the geological history of the area mainly in post-cretaceous times.

II. — TOPOGRAPHY.

Topographically the area consists of a dissected plateau. This «plateau» appears to be slightly warped about an E-W-axis, its maximum height being 210 metres above sea level. Morphologically, the area displays a number of steps which seem to subdivide it into several more or less horizontal plateaus of different altitudes. The different sub-horizontal or slightly inclined floors are partly erosion or denudation surfaces, partly structurally or tectonically displaced and tilted sub-units. Generally, such surfaces are developed parallel to and following primary structural or lithogenetic bedding planes. The first conspicuous plain is found at approximately 140 metres above sea level, while the second marked bench is met with at a level of 190 metres. Besides, there are a number of other minor benches of this type, sometimes called « table-mountains», « shoulders» which are met with at levels 100, 120, 180, and 200 metres above sea level.

The shoulder (governed mainly by stratification) 140 is the most important one as it divides the lithological and stratigraphical succession of the rocks of Gebel-el-Mokattam into a lower unit (Lower Mokattam) made of white limestone beds and an upper unit (Upper Mokattam) made of lithologically different limestones with marls and marly limestones which are mostly brownish in colour. This morphological feature is thus the re-excavated intraformational « bedding-plane», which parts the Middle-Eocene from the Upper-Eocene; a remarkable feature of high lithological importance. It indicates a sudden change, probably, in the greater structural control of Eocene sedimentation. Denudation surface 190 covers more or less horizontally the top-most preserved bed of Upper Mokattam. It, thus, corresponds to the surface 140 which parts the lower rock unit or Lower Mokattam. These surfaces thus represent :

(*a*) ancient surfaces of sea-bottom, or divisional planes of heterogenous facies.

(*b*) denudation-planes, or a combination of erosional local base-levels and even peneplains developed along such primary features. At least the highest level may coincide more or less with the

original peneplain of probably Miocene age and represent a subaerial surface. Mechanically these surfaces, benches, shoulders etc., are determined by harder silicified or dolomitised limestone layers of the topmost Upper and Lower Mokattam.

The surfaces are altogether barren. The scanty humidity met with in the area, is partly evaporated soon after precipitation, and partly quickly taken up by the heavily jointed rocks, (infiltration). Where fine-grained material e.g., clay — or marl — intercalations, is met with at the surface, dust-salt mixtures of various grain size, is usually developed as a fine dust. The efflorescing top-layer is gradually carried away by wind-action. Generally the surfaces are paved by a large number of coarser rock fragments (« deflation-residues» of E. Kaiser). No indications of active wind erosion are met with, since hardly any quartz sand is found on the plateau. Apparently, the high plateau was either stripped of its former clastic Oligocene cover or never had one.

In this respect, it should be mentioned that there is another type of well developed morphologically even surface which lies more or less at 80-60 m. above sea level. This surface extends to the south of the Citadel, below the escarpment of Gebel-el-Gioushy that overlooks Cairo city and on which lies the well known El-Gioushy mosque. It might represent a Nile-terrace of Plio-Pleistocene or later times. Its extent is considerable and it is mentioned separately since its origin is different from the origin of the « plateaus» dealt with above. The Gebel-el-Gioushy escarpment belongs to the Lower Mokattam rock unit and ends below the 140 m. shoulder, which is overlain by another well developed escarpment also running more or less in the same direction as Gebel-el-Gioushy escarpment. This higher escarpment forms as mentioned above, the Upper Mokattam rock unit which is distinguished from the Lower Mokattam by its difference in lithology and colour.

Everywhere in the area, it is obvious, that the morphology is mainly governed by denudation and lithology (Said, 1954). The minor dissection, however, originated by purely erosional developments. This erosion is witness of at least two great evolutions namely :

1. The Nile-Valley history.

2. The local erosion caused by periods of higher rainfall in the past.

The existing, drainage is partly exhumed (subfossil) and is determined by :

(*a*) the local base-level provided by the Nile-Valley, the history of which will not be dealt with in this paper,

(*b*) the lithological sequence of rocks,

(*c*) their mutual structural relations,

(*d*) the climatic changes of the past.

The main local water-shed is formed by the topmost Upper Mokattam ridge. This ridge is the result of the interaction of the E-dipping warp of the Mokattam with its Western escarpment. To the east of this divide the water drains into four main wadies that have an east-west direction and running away from the River Nile. The tributaries of these wadies have a north south direction running on the whole from south towards north until they meet the main drainage lines.

To the west of the divide, the wadies that drain the area follow a radial pattern with a south-east north-west direction in the northern part between Gebel Ahmar and the Citadel, and a north-east south-west direction in the southern part south of the Citadel till east of Maadi. The tributaries of the three main wadies in the northern part are running towards the north-east.

The wadies in this part of the area to the west of the divide are running towards the River Nile (Fig. 1).

III. — STRUCTURAL INFLUENCE ON THE MORPHOLOGICAL DEVELOPMENT.

The area in question is somehow distorted as will be seen in a later chapter. Previous authors explained the area as a sort of slight dome. It is worth mentioning that the situation is rather complicated and, that fracturing in every respect plays a more important role than folding or bending.

It has been found that many scarps, at least the south-looking ones of the area, are of structural origin, although the structural feature proper, actually still accompanies the morphological escarpment; only in some cases. Most of the present escarpments have, « weathered backs». The actual structure has thus been obliterated or covered by scree-deposits derived from the receding scarp itself.

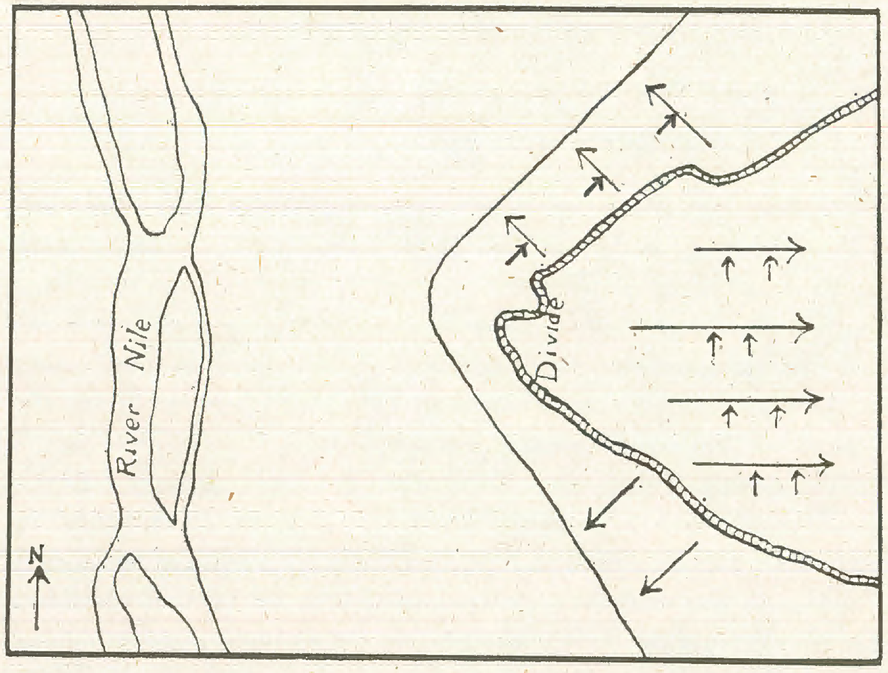


Fig. 1. Sketch showing main wadies and tributaries.

This assumption of a close relation between structure and morphology is confirmed by the « hydrological pattern», (the wadies, ravines and the whole dissection described before). Their « grid» is closely related to the joint and fracture pattern of the area. A comparison between the erosional direction diagrams and the structural diagrams of the area reveals this fact (compare Fig. 1 with Map 1).

In our region this « geological consequence» is typically developed. It has been mentioned that the fairly straight W-E main wadies on the « roof» of the Mokattam, have their tributaries draining approximately S-N. and forming at least two conspicuous systems.

These last named local drainage-units are created first by « gravity-drainage» down a slope coinciding somehow with the dipslope of the beds. At a later stage of their evolution, they selected lines of less resistance and cut themselves into the beds in question, thus underlining structural joint-grids.

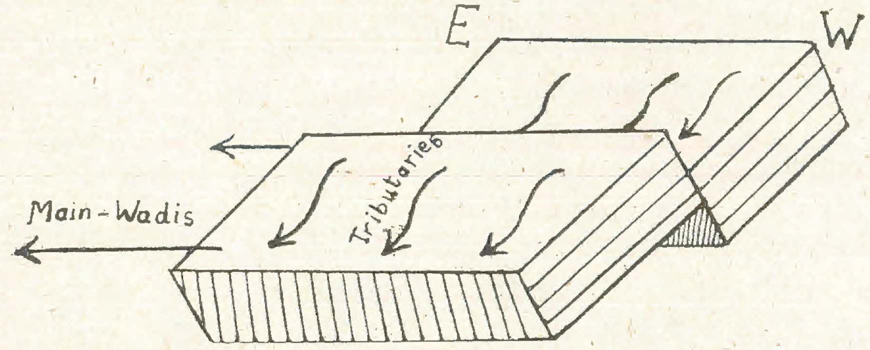


Fig. 2.

These north-sloping structural sections are always bordered to the south by a ridge (the water-shed) with a steep scarp pointing towards the S. or SSW. If we combine these systems, we find, that they clearly mark the antithetic block setting with its shallow dip towards north, and its fault scarp to the south. This scheme will be pointed out in a later chapter (compare the two block diagrams Fig. 2 and Fig. 3).

The main-face of the Mokattam is in all probability also formed or determined by structural events (*vide infra*).

IV. – STRATIGRAPHY.

The area concerned in this work is made of Middle and Upper Eocene rocks. The whole complex consists of limestones and marls of which the limestones are more conspicuous.

The contact between both divisions of the Eocene is shown on the geological map attached (map 1). It lies exactly between the two rock units namely the Lower Mokattam and the Upper Mokattam. The entire Middle Eocene in this area belongs to the upper part of this division (Upper Lutetian); the base is not exposed. The Upper Eocene present belongs to the Lower Bartonian stage.

Following the footsteps of Cuvillier, his two main sections in the area, the one E. of Kait Bey and the other E. of the Citadel (G. el-Gioushy) were measured again. The author expressed the main difference of including the bryozoa limestone in the Middle Eocene thereby making the contact between the Lower and Upper Mokattam at the denudation surface 140 (see chapter II, Topography).

As regards the Middle Eocene, the sections show that it is made of limestones which assume different petrographic characters at different levels thereby rendering contacts possible to trace for long distances. Although the different lithological and palaeontological units of the Middle Eocene may vary widely from one locality to another, yet there are three well marked stratigraphic horizons which throughout the progress of this work have served as controlling factors in correlation work. These horizons are namely, the Gasteropod, the *Nummulites gizehensis* and the building stone banks (beds No. 3, 6 and 8 of Cuvillier).

On the same grounds the two main beds of the Upper Eocene are the first and the second horizons of *Carolia placunoides.* (beds No. 4 and 6 of Cuvillier).

Since Gebel-el-Mokattam area is fairly well accessible, the previous literature is voluminous.

The first systematic work on its stratigraphy worth mentioning is that of O. Fraas in 1867 who recognized three horizons which he assigned as Lutetian in age. They are named from top to bottom :

3. The layers of Turritella or horizon of *Schizaster* africanus.
2. The horizon of the big Nummulites « *N. gizehensis*».
1. The « Baustein Horizon» or horizon of *Cerithium* giganteum.

In 1880 Zittel took the area as the standard section for what he called the « Mokattam Stufe» which he considered as middle Eocene. The lower limit of the Middle Eocene was marked by the appearance of *N. gizehensis,* Forsk.

Fourtau in 1899 in his early work stated that the Mokattam beds belong entirely to the Lutetian or Middle Eocene which he divided into Lower, Middle and Upper Lutetian. He mentioned that the general form of Gebel-el-Mokattam is an anticlinal dome which starts by the

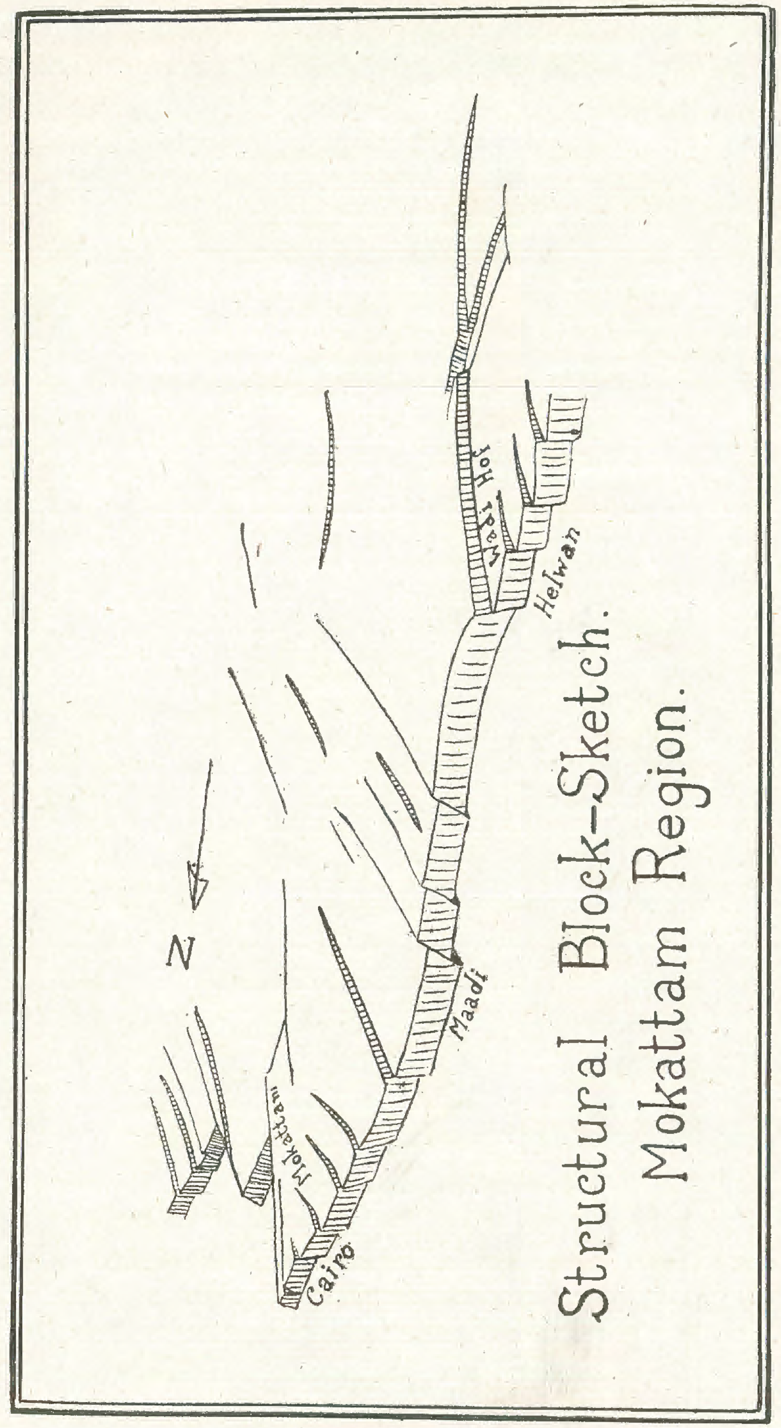


Fig. 3.

sands of the desert at Abbassieh north of Cairo and extends to the south ending at Wadi-el-Tih. Moreover he described a section to the east of Cairo at Gebel-el-Gioushy, which goes from top to bottom as follows :

15. Pleistocene covering the tompost surface.
14. Siliceous limestone.
13. Greyish marls with intercalating gypseous material.
12. Limestone with *Ostrea frassi*.
11. Blue Marls.

Limestones with :

10. *Ostrea elegans* Lam.
9. *Carolia placunoides,* and *Lucina pharaonis.*
8. *Schizaster mokattamensis.*
7. *Lobocarcinus* paulino-wurtembergious.
6. *Nautilus imperialis* and *Turritella quadrifaciata.*
5. *Pycnodus* teeth.
4. *Nummulites* gizehensis.
3. *Nummulites laevigatus, Nummulites ramondi* and *Plicatula polymorpha.*
2. *Nummulites perforata.*
1. *Echinolampus africanus, Nummulites distans* and *Nummulites Lucasanus.*

In 1900 Blanckenhorn made a refinement to Zittel's studies by subdividing Zittel's « Mokattam Stufe» into numerous stratigraphic horizons. He was the first to divide the Mokattam Stufe into Lower and Upper Mokattam based on a change in lithology and on a topographic delimitation whereby the Upper Mokattam is separated from the Lower Mokattam by a clear cut erosion surface.

Blanckenhorn correlated the « Mokattam Stufe» to the Parisian and Lower Bartonian of the then accepted stratigraphic horizons of the type locality of the Eocene of the Paris basin. He also introduced the name « Carolia Stufe» for the Upper Mokattam deposits which he considered identical to the upper part of the Parisian and the Lower Bartonian.

Blanckenhorn's sub-divisions remained valid and useful for a long time as the Lower Mokattam and Upper Mokattam are easily distinguished

from each other due to their different and characteristic lithofacies. This serve as good markers for mapping work, as one can just follow more or less the topographic configuration of the area.

Ball and Barron in 1900 seem to have accepted the divisions introduced by Zittel and Blanckenhorn.

Beadnell in 1905 disregarding what Blanckenhorn introduced, grouped the Lower and Upper Mokattam in the Parisian stage, by making a number of sections in these two divisions.

Boussac 1910 noticed the similarity between the siliceous limestone of Upper Mokattam to the Priabonian stage of Europe.

Hume in 1911 did not mention the Upper Eocene to be present at G. el-Mokattam. He classified the whole Middle Eocene into the following divisions :

Middle Eocene ...	Upper Mokattam — *Carolia* beds.
	Middle Mokattam — *Exogyra* beds.
	Lower Mokattam — *N. gizehensis* beds.

Fourtau in 1911 divided G. el-Mokattam to three divisions namely Lower, Middle and Upper Mokattam of which the two former divisions correspond to the Middle Eocene while the latter corresponds to the Upper Eocene.

The same author abandoning his earlier ideas of 1899 published in 1912, a thorough stratigraphic study of the area in which he added more value to Blanckenhorn's earlier divisions. He stated that the rock unit divisions of Lower and Upper Mokattam correspond also to time-rock units, thereby making the Lower Mokattam equivalent to the Middle Eocene (Lutetian) and the Upper Mokattam to the Upper Eocene (Bartonian). He, however, recognized that the top most layer of the Lower Mokattam is a palaeontologically unique division and therefore he distinguished it as the bryozoa limestone which he considered as « Auversian» in age. Moreover, he added that the Upper Mokattam is definitely similar to the Bartonian stage. Summing up, Fourtau gave the following table :

Upper Eocene (Upper Mokattam)	Limestone and Marls containing Plicatula Polymorpha and Ostrea Clot-beyi	«Bartonian and Priabonian»

Middle Eocene (Lower and Middle Mokattam)	Limestones with *bryozoa*	= Auversian
	Limestones with *N. gizehensis*	= Lutetian

Later on he considered the Middle Eocene as Lower Mokattam and gave the following divisions :

Middle Eocene	Limestones with *Schizaster africanus,* Lor. — Auversian.
	Limestone with *Euspatangus formosus,* Lor. — Lutetian.

Likewise Blanckenhorn in 1921 also considered the Lower Mokattam as Middle Eocene.

Cuvillier in 1924 accepted the ideas of Fourtau as regards the presence of both Middle and Upper Eocene in G. el-Mokattam and he even had the tendency to assign a Lower Oligocene age to the topmost part of G. el-Mokattam.

He proposed the following divisions :

Upper Eocene (Upper Mokattam) (Dark layers) or Bartonian		Beds characterised by *Nummulites beaumonti* and *N. Subbeaumonti*	Priabonian
Middle Eocene (white Layers)	Middle Mokattam (Auversian)	*b.* Limestone with Bryozoa full of small Nummulites *Operculina Pyramidum, Orbit. sp.*	Parisian
		a. Hard Limestone with *N. discorbina N. subdiscorbina* and *N. beaumonti.*	
	Lower Mokattam (Lutetian)	*g.* Limestone with *N. curvispira, N. laevigatus.*	
		f. N. curvispira, Operculina pyramidum.	
		e. N. globulus, N. subramondi, N. gizehensis and *N. curvispira.*	
		d. Small Nummulites.	
		c, b, a. Big Nummulites and *Miliolides.*	

In 1927, Cuvillier placed the « Auversian» age as representing both the Upper part of the Lutetian and the lower part of the Bartonian as

he found *Nummulites atacicus* and *N. beaumonti* in the lower part of the Auversian together with *N. contortus* and N. striatus in the Upper part which characterise the Bartonian.

In 1930 Cuvillier climaxed his career in Eocene stratigraphy by publishing his famous « Nummulitique Egyptien». He considered the major part of the Lower Mokattam as representing the upper part of the Middle Eocene equivalent to Upper Lutetian. He followed the footsteps of Fourtau and emphasized the identity of the top layer in the Lower Mokattam. He put the boundary between the Upper and Middle Eocene at the base of this top layer which is the limestone with bryozoa. He excluded the bryozoa limestone rejecting the name Auversian and considered it as equivalent to the lower most part of the Upper Eocene. So, he lumped the bryozoa-limestone with the Upper Mokattam, as Upper Eocene which corresponds to the Lower Bartonian stage. This change in the position of this horizon was based on pure palaeontological grounds. Cuvillier's conclusions therefore added a further complication to the field geologists in the sense that the easily recognized mapable rock units of the Lower and Upper Mokattam did not coincide with his new time-rock units.

The same author divided the Middle Eocene into Lower and Upper Lutetian according to their large foraminiferal content e.g. *Alveolines* and *Orbitolites complanatus* which are present in the Lower Lutetian while *Nummulites gizehensis* and *Nummulites beaumonti* are present in the Upper Lutetian. According to the echinoids and molluscs this division could not be easily applied.

To sum up, Cuvillier introduced the following divisions :

Upper Eocene	Upper Bartonian (Not present in G. Mokattam)	Beds with *N. fabianii* and *N. chavannesi*	Qasr el Sagha series of the Fayium
	Lower Bartonian	Limestones with *N. contortus* and *N. striatus* together with limestone with bryozoa	Upper Mokattam and topmost beds of Lower Mokattam

Middle Eocene	Upper Lutetian	Limestones with *N. gizehensis* and *beaumonti*	Lower Mokattam (major part)
	Lower Lutetian Not present in G. Mokattam	Limestone with *Orbitolites* complanatus and Alveolines.	

Cuvillier's work remained for a long time as the standard and most complete work on the subject until Bishay's recent thorough work in 1953. Bishay in an attempt to zone the Lower and Upper Mokattam by means of the larger foraminifera arrived to the following results :

The base of the exposed Lower Mokattam is marked by *Nummulites gizehensis*. Overlying it he could recognize four zones in the Lower Mokattam which he considered all as belonging to the Upper Lutetian. He also found one zone in the Upper Mokattam which he assigned as Lower Bartonian. The material he studied was only collected from one section to the east of the citadel, from the uppermost rocks of the Upper Lutetian (above the Nummulites gizehensis bank). The five local zones introduced by Bishay are as follows from top to bottom :

	(*Zones of*) :
Upper Eocene (Upper Mokattam)	5. *N. contortus* — *N. bericensis* (Thickness 8.5 metres)
Middle Eocene (Lower Mokattam)	4. *N. burdigalensis* — *N. discorbinus* (Thickness 12.5 m.)
	3. *Gypsina carteri* — *Linderina brugesi* (Thickness 5 m.)
	2. *Dict. aegyptiensis* — *Orbitolites* (Thickness 5 m.)
	1. *Mokattamensis* — *Discorbina nudimargo* (Thickness 5.5 m.)
	Zone of *N. gizehensis*

Some of the species identified have a very short range and thus are of great stratigraphical importance namely : *N. burdigalensis*, De la Harpe, *N. contortus*, Deshayes, *N. bericensis*, De la Harpe, *Linderina brugesi*, Schlumberger and *Orbitolites complanatus*, Lamarck. Some other

species although starting below the section discussed above were of great help in locating some of the zones namely : *N. mokattamensis*, sp. nov. (Bishay), *N. discorbinus*, Schlotheim, *Dict. aegyptiensis* (Chapman), *Discorbina nudimargo* (Schwager), *Discorbina variecostata*, Gumbel, and *Gypsina carteri*, Silvestri.

In his work Bishay rejected the idea of assigning an Auversian stage to the bryozoa limestone since he found that this horizon contains larger foraminifera which are typically Upper Lutetian in age. Accordingly he confirmed the boundary between the Middle and Upper Eocene to be present just where the lithological change occurs between the Lower Mokattam white series and the Upper Mokattam brownish series. Thereby he adds palaeontological evidence to the Middle-Upper Mokattam subdivisions.

It is worth mentioning that there was a marked difference in lithology between two successive samples, one from the topmost part of the Lower Mokattam which is a hard white limestone with very thin occasional bands or marls, while the other is from the lowest part of the Upper Mokattam which is composed of marls or marly limestone. At that boundary some typical Upper Eocene species as *N. contortus* and *N. bericensis* appear for the first time, while a typical Lutetian species as *N. discorbinus* disappears. Although *N. beaumonti* does not disappear at that boundary yet it is known to be present elsewhere in the Upper Eocene. This shows that both lithologically and palaeontologically the boundary between the Middle and Upper Eocene should be taken as between the white and the brown limestones, that is at the erosion surface 140.

Thus it is clear that the upper limit of the Middle Eocene has been the subject of much controversy, so when dealing with this point the author accepted its precise position fixed by Bishay and used it while mapping, the area. However, this demarkation is only local and is not yet applied everywhere in Egypt.

The following table is an attempt to summarise the previous work to make the comparison easy and to show how controversal was the problem of dividing the Middle and Upper Eocene.

TABLE SHOWING THE PREVIOUS AND THE PRESENT DIVISIONS OF GEBEL MOKATTAM

		FOURTAU 1899	BLANCKENHORN 1900		BEADNELL 1905	BOUSSAC 1910		HUME 1911
Upper Mokattam (Upper rock unit)	Middle Eocene (Lutetian)	Upper Lutetian	Upper Mokattam Carolia Stufe (Lower Bartonian and Upper Parisian)	Middle Eocene (Parisian)	Upper Mokattam	Upper Mokattam (Pariabonian)	Middle Eocene	Upper Mokattam (Carolia beds)
Lower Mokattam (Lower rock unit)		Middle Lutetian						Middle Mokattam (Exogyra beds)
		Lower Lutetian	Lower Mokattam (Parisian)		Lower Mokattam	Lower Mokattam (Parisian)		Lower Mokattam (Nummulites gizehensis beds)

	FOURTAU 1912		CUVILLIER 1924		CUVILLIER 1930	BISHAY 1953			N. AZER 1964
Upper Eocene	Upper Mokattam (Bartonian or (Priabonian)	Upper Eocene (dark layers)	Upper Mokattam (Bartonian)	Priabonian Upper Eocene	Upper Mokattam (Lower Bartonian) — — — Topmost beds of Lower Mokattam (bryozoa limestone)	Upper Eocene (Lower Bartonian)	Zones 5	Nummulites contortus N. bericensis	Lower-Upper Eocene = Upper Mokattam (Lower Bartonian)
Middle Eocene	Middle Mokattam Limestone with bryozoa (Auversian)	Middle Eocene (white layers)	Middle Mokattam (Auversian)		Middle Eocene (Parisian)	Middle Eocene (Upper Lutetian)	4	N. burdigalensis N. discorbinus	Upper-Middle Eocene =
							3	Gypsina carteri Linderina bruges	
							2	Dict. complanatus Orbit. complanatus	
	Lower Mokattam Limestone with Nummulites gizehensis (Lutetian)		Lower Mokattam (Lutetian)		Lower Mokattam (Upper Lutetian)		1	N. mokattamensis Bishay Discorbina nudimargo	Lower Mokattam (Upper Lutetian)
						Zone of N. gizehensis			

V. – TECTONIC ANALYSIS OF THE AREA AS KNOWN SO FAR

Comparatively few data about structural details in our area are given by previous authors. The first who mentioned some data about the structures, was Fourtau in 1899. He stated that the general form of G. el-Mokattam is simply an anticlinal dome which starts by Wadi-el-Tih south and extends to the north of Cairo where it ends at the sands of the desert at Abbasieh. He gave a sketch to illustrate his ideas. Fourtau made use of the fossil fish teeth horizon exposed on both sides of the Nile at Gebel-el-Gioushy to the E. and at the Giza pyramids area to the W. This horizon being not at the same level in both localities with a difference of about 150 metres lead him to assume a fault line in between the two areas that is represented by the Nile Valley proper.

Blanckenhorn (1921) traced five faults in the area E. of Cairo included in his map of Egypt (Tafel I.) which is attached to his work. The northern fault in our area (G. el-Mokattam) is in an E-W direction while the southern fault line is a major one and extending to a great distance in a NW-SE direction. The three other faults lying between the ones mentioned are running towards the W-NW. The direction and the presence of some of these faults assigned by Blanckenhorn agrees somehow with the present work.

Hume in 1926 considered the area as an anticline with its two limbs present. He mentioned nothing about other structural features but emphasized his anticlinal conception by the presence of Oligocene formations bordering the area from the N. At G. Ahmar and from the S. at G. el-Ghashab.

Shukri and El Ayouty in 1953 mentioned that the general direction of the fault lines is towards the NW. The first actual mapping of structures east of our area has been done by G. Akmal (ref. Shukri and Akmal 1953). In the following pages, new data are brought forward and a structural synthesis of some sort will be tried.

The field-data recorded are, however, by no means complete. Actually, it will not be possible to construct a proper and reliable structural map before a detailed one has been created.

The present topographical maps are somehow useful but by no means suitable for large scale geological mapping. Therefore the following attempt should be regarded as preliminary.

VI. – STRUCTURES AND TECTONICS OF THE MOKATTAM AREA.

The heading of this chapter makes a difference between « structures» and « tectonics». This difference is rarely made in literature but, some stress has been put in the present investigation. We comprise in structure « the *direct* and *indirect indications* of *tectonical movements*». This means that the difference is based on a *dynamic tectonical evolution* producing static indications, surfaces, divisional planes, respectively « structures».

Therefore, structural details in an analytical manner will be investigated in order to reconstruct synthetically the tectonic events which created the structures (compare E. Wegmann 1950) in our region.

It was found out that the first selected regional « frame» of the investigation was too small to allow actual basic considerations of a synthetic character. Therefore the region under consideration has to be widened as far as detailed investigations of neighbouring areas did allow this.

To go a second and indirect way the lithological development of these areas, were also taken into consideration since it is perfectly clear in our region that sedimentation or facies is thoroughly governed by tectonical evolutions within and outside the region proper.

Another terminology must be reconsidered : In some chapters a difference between « minor» and « major» structures is made. It is understood that minor and major events or indications of events are in the first line an « anthropomorph» (i.e. man-size scale adaption). Actually the difference of minor and major structures in this investigation means the « relativity» of the indication. So the joint is minor in respect to faulting or folding, the faulting is minor in respect to the « Red Sea Graben formation» and so forth. Therefore too much stress should not be put on the expression minor and major and, whenever necessary, we shall explain how the term is actually meant.

As a matter of fact, in a recent work (Mayer Y., 1953) it has been proved that even through a comparatively thick section of alternating competent and incompetent beds minor and major structural elements

are more or less parallel; if carefully screened by unpartial statistical methods. It will be seen, that in our smaller area consisting also of competent and incompetent beds, although the competent beds exceed in the visible portion of the section, the minor (in size) structures sum up to considerable amounts of displacement or compensation movements compensating in their total effect just as one single or few fault lines of greater extent. However, the direction of the Upper Eocene jointing locally deviates considerably from the Middle Eocene fractures (map 1).

The area in question has been described above (Chapter I). From the orographic or rather geological point of view, the Mokattam is the northern-most end of a nearly continuous escarpment of limestone-table-mountains which accompagnies the Eastern desert side of the Nile Valley for hundreds of kilometres. It shows, on the whole, a broken scarp dissected by wadies draining a more or less dissected landplain behind, which comprises the whole calcareous Eastern Desert.

It is very conspicuous on every geological map of Egypt — that the area East of the Nile *shows* an overlapping succession of a young calcareous (and marly) blanket above the Nubian-sandstone-intercalation between this blanket on top and the basement formations underneath. This main outcrop difference between the Western desert and the dissected and geologically colourful Eastern Desert is due to the slight inclination of the Eastern portion of Egypt which gave the drainage of this Eastern Desert increased velocity and scouring or erosive power. Meanwhile, in the Western Desert practically no great Wadies occur in spite of the fact that on the whole, climatic conditions of the past were equal in both portions of Egypt.

This is the reason why we have better exposures in the East. Therefore the greater and different structural wealth is present in our area in comparison to the Western Desert.

Besides, the boundary between the two areas is apparently the Nile-Valley proper. This was considered by provious authors, especially in the vicinity of Cairo, in direct connection with the Mokattam scarp-faces, we are dealing with. Likewise this gave rise to some controversial theories and discussions in the first half of this century directly connected with this work.

VII. — NEW STRUCTURAL ANALYSIS OF THE MOKATTAM AREA.

Together with this work a number of cross-sections are attached. They comprise the results of a thorough field investigation based on personal observations and maps compiled by previous authors.

In a previous work by N. Azer. (1962) Map 1, shows a general cross-section from West to East through the « Lower quarries» and the Mokattam scarp. It shows the inclination of the beds and their fairly safe correlation. The master joints (meaning very conspicuous joints with hardly noticeable movements but still resembling the extent of a small fault line) represented in the cross section are shown on (map 1) of the present work. They are not always cut normally by the profile-section. Their strike has been recorded on the joint diagrams included in this map. This method is rather old-fashioned but in our region, consisting mainly of limestone beds (as far as the properly jointed complexes are concerned) that have been slightly tilted or distorted, the dip of the most bigger joints is nearly vertical. If they are slightly inclined, 80° or 70° for instance, this inclination either depends on the local inclination of the beds, or it says nothing, i.e., the mechanical explanation is so hypothetical and complicated that it is unsafe from the analytical point of view. A number of « intraformational grabens» which are dealt with below, show inclined boundary faults.

From the map and the included diagrams (map 1) it appears that the jointing in the Upper Eocene portion is :

(*a*) Far more frequent than in the Middle Eocene limestones, at least in the thin competent beds of this group.

(*b*) It partly deviates from the directions obtained in the Middle Eocene portion.

This can be explained by the fact that (*a*) thin beds break at shorter distances than thick-ones and (*b*) possibly by the assumption gained by field observations that the tectonic direction has been changed in later times, i.e., especially in post-Upper Eocene periods, or, that the Upper-Eocene — outcrops are at some distance from the Middle Eocene record-areas.

On the whole, the diagrams as well as (map 1) give a clear fan-shaped joint-picture of the region, which opens towards NW.

This coincides with the distribution of the major faults. The whole area is faulted and the shallow distortion producing the slightly dome-shaped appearance of the Mokattam is of minor importance. We find a number of fault lines, dissecting the Mokattam plateau as a unit and we find boundary faults of the Mokattam, bordering it towards the NE and towards the SE. The last-named fractures seem to be of a higher order, while the first named, mainly E-W faults dissolve the higher or greater order into smaller units. These seem to be mainly pivotal faults with a considerable variation of throw-amount and are partly replaced by flexures or short monoclines (Fig. 4).

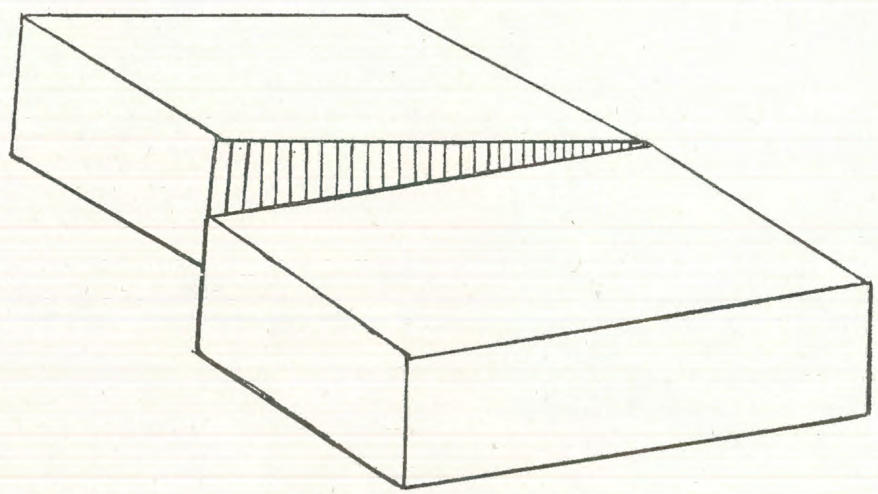


Fig. 4.

Concerning the age of these faults it is not yet sure. The author has the impression, gained by field observations, that some of the E-W faults show a higher throw figure in the (lower) Middle Eocene portion than in the (higher) Upper Eocene part. This would mean that they either originated during both formations or rather on the boundary between Middle and Upper Eocene times. This time was somehow disturbed in a greater frame as shown by the extreme difference in lithology. It might be disputed whether or not a different, later

compaction of both series might produce such effects of different throw-figures in faulting cutting both units. Still, the faults might or even must have been revived at later times (as the other system) since — in the wider vicinity, clear EW faults dissect and displace Miocene beds (Shukri and Akmal, 1953).

As far as the NW set is concerned, these faults, now bordering the Mokattam-region proper were used as planes of movements during or at least directly postvolcanic times since the silicasolutions along the Gebel Ahmar line rose along these planes and silicified at least Oligocene clastic sediments.

A number of large scale cross-sections concerning the jointing and small faulting phenomena in the Middle Eocene shows that — in a large percentage of these joints and small faults — we meet with divisional planes confined only to a portion of the whole series. Some of these fractures even produce « intraformational grabens» (Plate III, A). It cannot be anticipated that the faulting or jointing took place only during portions of the Middle Eocene since otherwise (*a*) corresponding sedimentary phenomena would have been met with (*b*) neither would such faults die out towards depth. This possibility was checked carefully and came to the conclusion that such features can only be explained mechanically, i.e. by the different compensation-needs of different beds or beds of different lithology or reaction capacity during long-lasting (not sudden) tensional movements. Since the inclination of the beds, (which during lithification may have produced such features), is very low or even missing, such tension must have been of tectonical origin.

These and other features to be mentioned below show that even in a more or less vertical structural evolution, a considerable bedding-plane-parallel reaction takes place. This internal readjustment is highly remarkable. Therefore, in a sequence of alternating hard and weak beds a tension or compression may be compensated by fractures or a buckling simultaneously as well as by a plastic reaction or by bedding-plane-parallel localised movements. Now this fact is well known in intraformational folding, in series with swelling or shrinking intercalations, in the dying out of fractures in incompetent intercalations. Such

a fact has not yet been recorded in such a clear way showing that faults of a throw of more than one meter completely die out within a vertical distance of few meters. Some of our « petty » horsts or grabens are actually confined to particular layers within the Middle Eocene section.

A surface mapping of these features and a consecutive planning for practical purposes would probably under such circumstances lead to some failure.

This paper shall not give a mechanical analysis of the relation between lithology on one side and fracture distance on the other; a statistically solvable problem. Also it will not deal with the same relation with respect to the thickness of the beds in question. These points have only been pointed out to show that there are further problems of some practical value.

Another case of this kind may be mentioned. This appears in a number of shovel-like or «listric» planes displayed in the lower quarry-area (Azer, 1962); a feature which is rather frequent. The divisional planes are partly clearly developed as « shovels» compensating a tension or « increase of surface» of the particular beds by rotational gliding of fracture units, displaying partly a sigmoidal appearance (Omara 1953) which might be due to a later bedding-plane-movement distorting the originally even joint planes. The question could not be settled, since the direction of tension in one portion of the quarries, shows that in two nearly consecutive beds the tension direction is directly opposite to each other. This indicates either a very complicated strain-distribution in a « ply-wood-like» set of beds or a consecutive development.

Therefore the solution of this question must be left for the future. It may be just as well due to a compaction-effect of a whole series of different competency probably under stress, thus indicating bedding plane parallel movements making preferred use of less competent and « more» plastic layers between hard beds of limestones. The lower layer in question is confined to the top-portion of a generally competent limestone bed. A difference in lithology within this particular layer from botton to top could not be stated. It can, however, be anticipated (according to experiences made in the resistance-capacity of technical

material) that a lithological difference may indicate itself by this different mechanical reaction.

On the whole, this cross-section showing jointing-particulars is not dealt with in detail in this work. It is nothing but a registration for future work that should give a detailed structural situation-plan.

Together, with the distribution of the major tectonics of the surrounding area, they give a remarkable confirmation that, in the Mokattam area or the Nile Valley proper we stand at a tectonic point or line of some importance.

VIII. — TECTONIC ANALYSIS OF THE MOKATTAM-FIELD TOGETHER WITH ITS WIDER VICINITY.

Tectonic Mokattam-field with its wider vicinity « means the Mokattam area itself « with its tectonic frame, i.e. including the Abu Rawash district, the Eastern portion of which is represented by the Western bank of the Nile in the Giza pyramid area, the Wadi Hof complex in the South and the Nile Valley itself.

Towards the East, the field passes gradually into the Cairo-Suez-Road area attempted recently in a key-portion by G. Akmal (1953). The mechanical plan of the area (Fig. 3) comprises a fracturing field with the two main directions represented in the Mokattam and a combined series of tilted block-units, entirely different from the general appearance of the Syrian arc region (Krenkel, 1925) to which it belongs. These tilted block units were produced by varying tensional stress, probably simultaneous with the numerous fractures present in the area.

In general, the Syrian arcs (Fig. 5) are represented by a number of compressional features, bucklings, warps and series of slight anticlines and synclines. These distortion-areas are not continuous but, as Krenkel already pointed out, from a loose pearl- string-like arrangement that comes from the Palmyra chain area in Syria, arcs through Palestine and the Northern portion of Sinai and practically dies out near the Gulf of Suez fracture zone. Now, it is known since some time (Cloos, 1948) that fracturing and folding proper are enemies». The Syrian arc is a clear folding feature and the Gulf of Suez belongs to the greatest fracture

zone on earth; the Red Sea Graben. Therefore, the ceasing of the folding activity whether or not directly referable to the tension fracture with its axis normal to the folding near the fracture-belt, is nothing astonishing. But, the folding should actually begin again West of the Gulf of Suez; a feature which does not exist. There are clear bucklings, warps and even sharp bends in the young cover formations but apparently no actual folds comparable to the normal Syrian arc features. Folding begins at Abu Rawash only, including the Giza pyramid area.

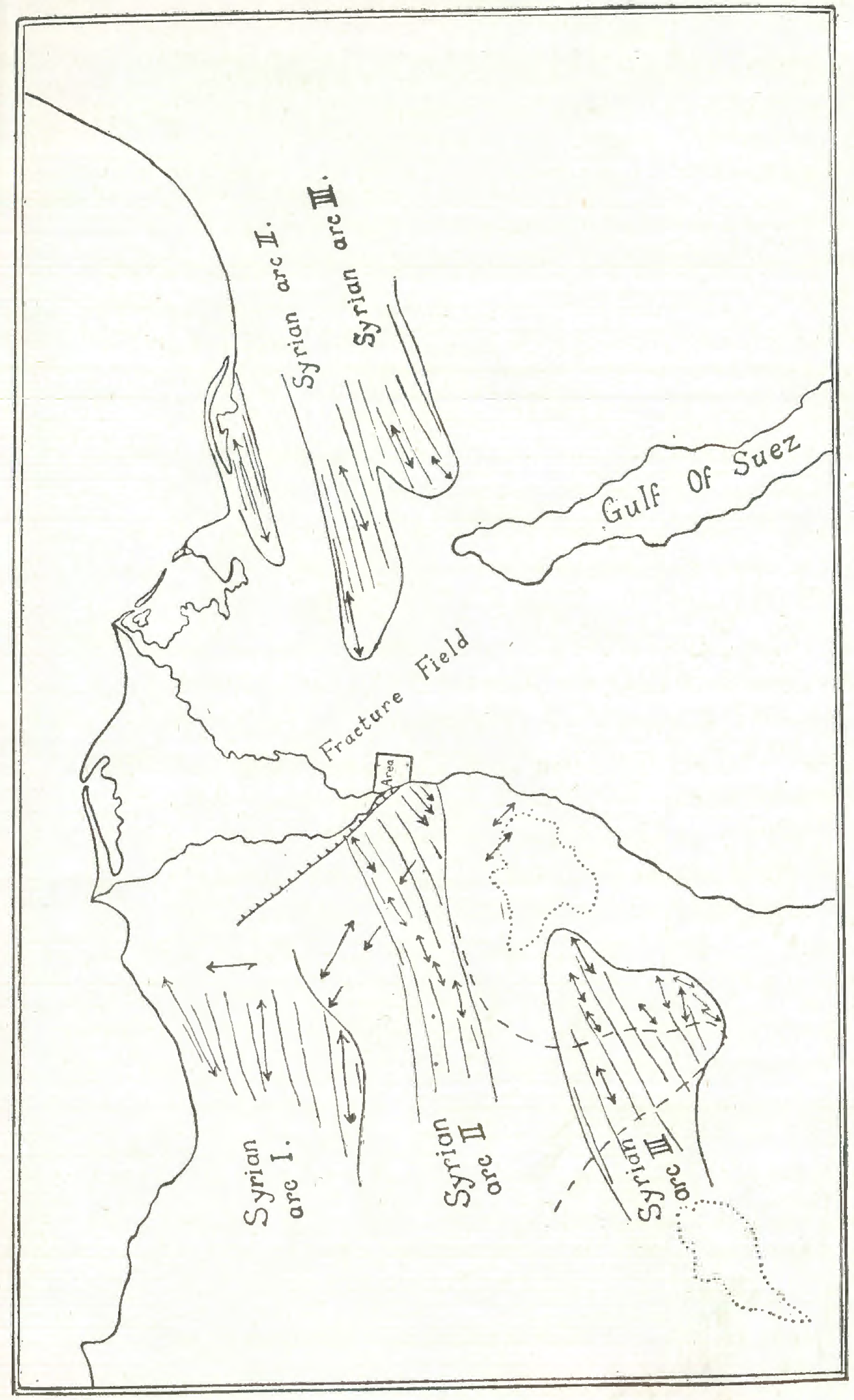
In between i.e. from Suez to Cairo we have another tectonical reaction, a fracturing accompanied in some places by these slight warps and features, a combination of bending and fractures (« Bruch fallung» of Stille 1949). This peculiar fact must have some reasons.

Fig. 5 speaks for itself, showing the folding center of Abu Rawash. This area according to (Omara 1953) has been folded properly at late—cretaceous or directly post-cretaceous times, furthermore slightly distorted during and post-middle Eocene times and finally (according to some observations offered by Chata, 1953) distorted at probably late or post-miocene times but then with a differently oriented axis.

The orientation of the folding axes up till the Upper-Eocene times and possibly some time later was clearly NE with a slight deviation to the E. in the eastern portion. This means that there was some sort of compression in a general NW-SE, direction.

It is known that for some time in the following period, when the actual Red Sea depression came into existence, there was a clear tension with fractures pointing in the direction just mentioned NW-SE. This fact shows clearly, that this tension ran mechanically normal to the compression of the past. This might indicate that the earth crust was overstrained and ruptures took over the role played by a weak compression of the past. The forces could have been the same, only the reaction of the crust have been changed due to the fact that stress exceeded the strength of the rock to the extent that bending was replaced by ruptures.

Now, folding always implies the presence of folding-ready material i.e. a certain amount of sedimentary material (Lee 1953 denied this but he might be wrong). Therefore, one can just as well say that only in portions where there was a certain amount of sedimentary cover,



Structural sketch-map of Northern Egypt

Scale 1:2,000,000 — 200 kilometres

Fig. 5.

folding occurred, while in neighbouring regions where the sedimentary cover was thinner, the folding was mechanically replaced by other reactions as fractures, flexures, warps and likewise.

It is difficult to prove that this was the case in this definitely different region West and East of the Nile. Since the great SW delta fracture now comes into the picture indicating a fracturing feature proper and a rupture-reaction of nearly Red Sea size, it may be anticipated with some right that the River Nile flows along a border line between two portions of different behaviour, (*a*) the Cairo-Suez road portion displaying nearly a « basement-type» of fracturing and (*b*) a folding type proper in the West. If this is the case, the Delta itself might be nothing but a West-displaced portion of the Gulf of Suez, probably mechanically created by the NNW-extension of the Eastern desert basement spur in the deeper subsurface (compare any geological map of Egypt). If we follow this idea and try to prove its validity by other lithological means we find that (see Fig. 5) (1) the syrian inner (southern) arc runs right round this proposed «basement peninsula», (2) the Oligocene-Miocene indentation between the Faiyum and Baharyia Oasis gives its Western outlines and, the Wadi Araba cuts right across it. The Wadi Araba is according to recent informations (Knetsch 1953) a horst and not a proper anticline, since it is bordered by considerable fault lines. This would mean a sharp bending-down of the basement-spur towards the Mediterranean field in comparatively younger times and below only a shallow blanket of young formations. This would also explain the fracture field connecting the two « wings» of the Syrian arc system East of the Gulf-of-Suez and West of the Delta — fracture — zone. Further it explains the arc-like shape of warping-axis and fractures from the inner Syrian arc towards the Cairo-Suez-area as well as the fan-shaped fracture-arrangement in the wider Mokattam field.

In any case, surface phenomena indicate a clear tensional stress along a curved belt just outlined. The compensation of the surface-increase coming from every tension, means an increase in surface rock-matter which become very weak against tensional stress. As an ultimate result, this gives rise to a system of « key-stone-setting» units or antithetic blocks, typically represented in our area (Fig. 3).

Since the tension was not located in a narrow zone but rather widely spread, this settling took place in a step-fault manner with mainly antithetic step-arrangement (see block diagram, Fig. 3). It corresponds thus with some boundary areas of the Red Sea Graben (Quoseir-district, Knetsch 1953). In our particular area the main trend of these step faults is (*a*) in the higher-order-set NW-SE. (*b*) in the second-order-set E-W. The whole situation is made clear in a block diagram (Fig. 3). The two systems have been already discussed above. It is doubtful whether they were created at the same time, as both have been rejuvenated several times. Since, in Wadi Hof area, the two systems do intersect each other with no apparent difference in age, so it could be anticipated that they belong to a mechanical system comparable to and corresponding mechanically to the two main D-joint-systems developed in anticlines with mainly competent beds (Omara 1953).

This would mean that the direction of tension mechanically corresponds perfectly well to the compressional directions which created the Syrian arcs of Abu Rawash, pyramids area and Northern Sinai on the other side. This means that they belong to the last phase of this compressional mechanical plan, producing the change from bending to fractures.

According to personal observations, it seems essential to emphasize the suspicion that the compressional element did change direction in late Miocene or post-Miocene times. The late compressional features in the Western desert show nearly a NW axis, i.e. an axis nearly normal to the former compression. The corresponding tension would produce NE-fractures. Their existance is not easily proved, but the NE-face of the Mokattam may have been created originally by a fault line defining equally the SW boundary of the Delta near Cairo. A clear NE — silification zone in the SE-portion of the Mokattam also proved the existence of this direction. However, this is going too far into a hypotetical field. It has only been mentioned because some future investigations should be directed in that line to prove or disprove the ideas offered above.

On the whole, the area displays a widely scattered fracture field belonging to one mechanical scheme and representing a special type of earth-crust-units. In situation and origin, probably the earliest representative of the Red Sea Graben formation is still placed into

end-oligocene times. As mentioned before, the author assumes that our fractures originated a bit earlier probably even simultaneous with the folding periods of the West, that means directly following and even accompanied the Eocene top-most series. The fracture systems however have been revived several times, in Oligocene times or early miocene (= volcanism), in post or late miocene times (displacement of basalts), and probably even at a later period.

In our area, the fracture systems show a « replacement» of folding tectonics proper which are responsible for the syrian arcs (Krenkel, 1925), in a field that might carry a shallower sedimentary cover than the arc regions proper. This may be either due to a near basement spur in the subsurface or unlikely to an end-cretaceous or early Eocene folding belt in the subsurface which gave rise to a stiffened basement complex underneath. This would be a corresponding continuation of the Abu Rawash system. For some reasons the author is inclined to anticipate a pronounciation of the basement in the underground.

Besides the Mokattam area stands in the diffuse of echelon-continuation of the Gulf of Suez-fracture field, exactly at the intersection of the SW-Delta fracture with the most likely but not doubtlessly proved SE Delta fracture. These two main fractures or faults combine to form the trumpet-shaped Delta « Graben» area, which means that the Nile Valley between the Giza pyramids in the West and the Mokattam in the East is actually a shallow Graben (Fig. 5). This statement is however no support for the Nile-Valley-Graben theory of former times, since this coincidence is merely local and the Maadi-Graben, as we could call this feature, strikes NW-SE and looses itself in the Eastern Desert. The Nile only crosses it obliquely, to the west of our area.

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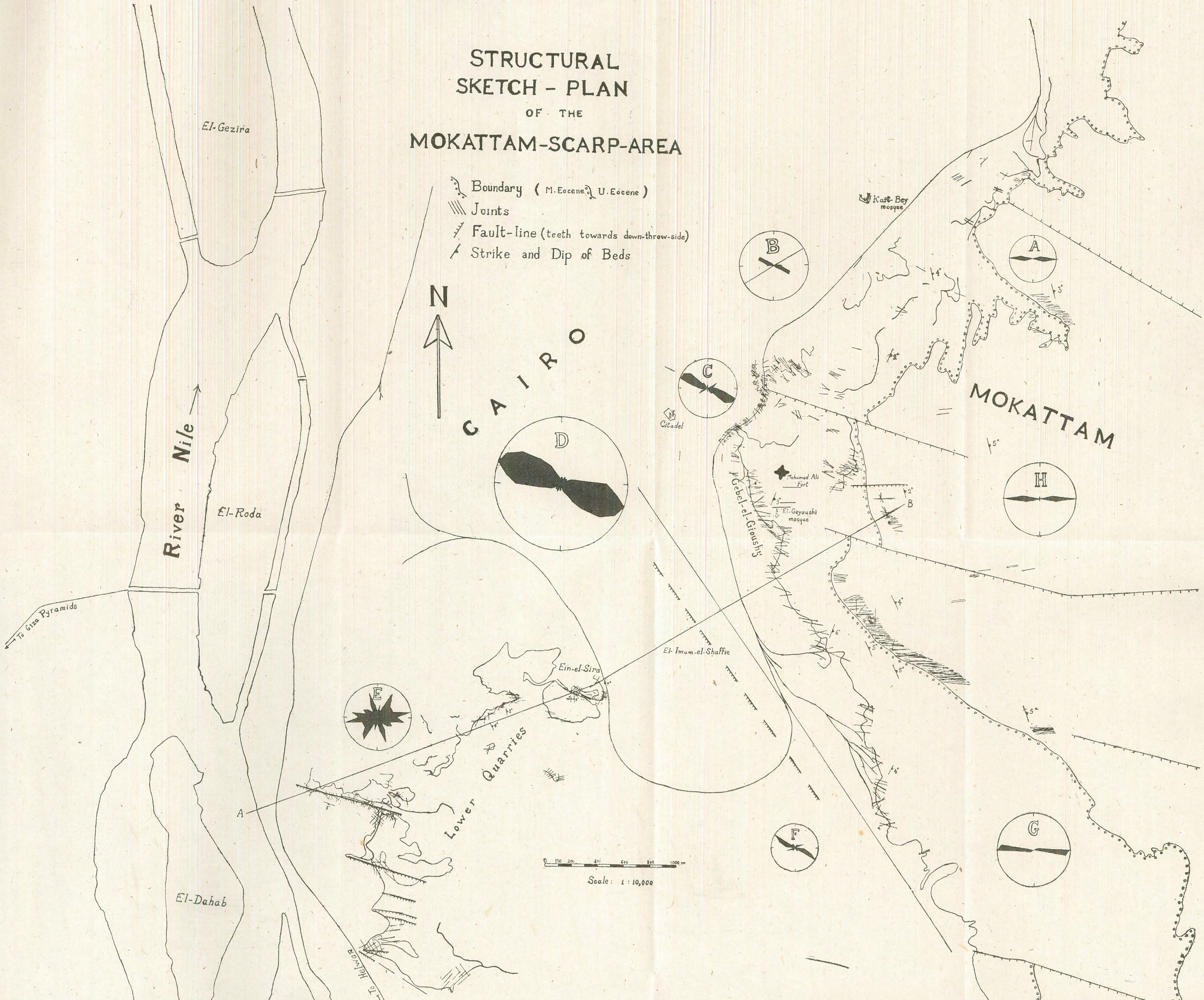
MAP 1


STRUCTURAL
SKETCH - PLAN
OF THE
MOKATTAM-SCARP-AREA
Boundary (M. Eocene U. Eocene)
Joints
Fault-line (teeth towards down-throw-side)
Strike and Dip of Beds
N
CAIRO
MOKATTAM
El-Gezira
River Nile
El-Roda
El-Dahab
To Giza Pyramids
To Helwan
Lower Quarries
Ein-el-Sira
El-Imum-el-Shaffie
Gebel-el-Gioushy
Citadel
Mohamed Ali Fort
El-Geyoushi mosque
Kait-Bey mosque
A
B
C
D
E
F
G
H
Scale: 1 : 10,000

A. — Panorama of G. Mokattam escarpment from G. Ahmar NE to the citadel SW. The Middle Eocene is overlain by Upper Eocene scarp.

B. — Panorama of G. Mokattam scarp (G. El-Gioushy) starting from the citadel NNW to east of Maadi SSE. The Upper Eocene scarp is seen overlying that of Middle Eocene.

PLATE II

A. — The northern end of the Mokattam scarp (G. El-Gioushy), looking NNE and showing the Gioushy mosque on the topmost part of the Lower Mokattam.

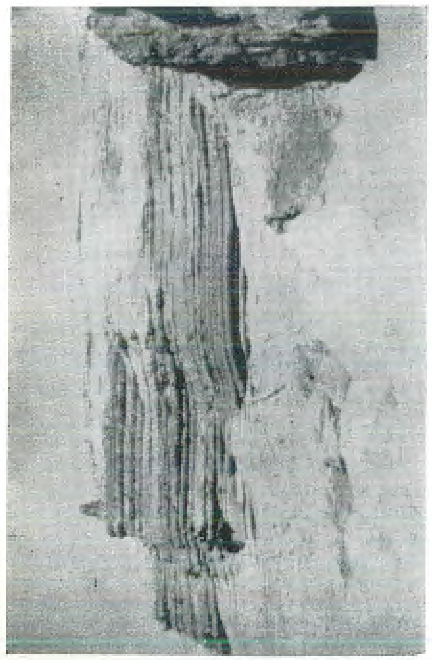
B. — The Mokattam scarp (G. El-Gioushy) just SW of Pl. II, A. The exposure was taken from above looking SSW, to show part of the denudation surface 140 and the lower bench 80 which extends to the right of the photo.

C. — The Upper Eocene scarp (Upper Mokattam) over the greatly extended denudation surface 140. The exposure was nearly taken from the same spot of Pl. II, B, but only looking SE.

D. — The Upper Eocene exposure, S.E. of El-Gioushy mosque by about 300 m. It shows the different horizons of the siliceous limestones which are greatly dissected by more or less E-W joints.

B

D



A

C

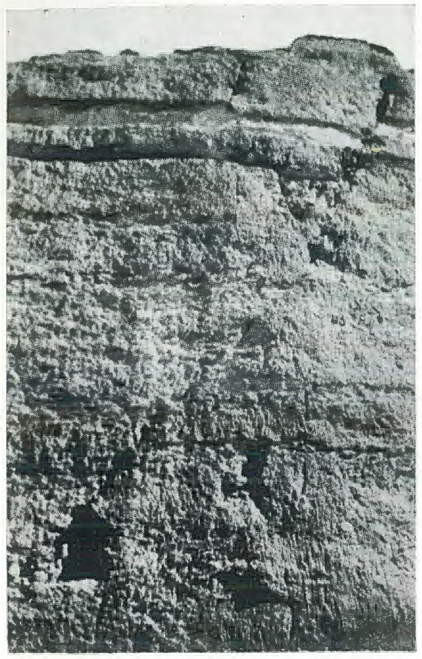
PLATE III

A. — A minor graben at the top part of an old quarry in the Middle Eocene at the foot of the northern end of G. El-Gioushy.

B. — A minor fault line exposed in the old quarries at the foot of the northern end of G. El-Gioushy. It is striking EW and dipping with an angle of 60° to the south. The vertical displacement amounts to about 1.5 metres with the downthrow to the south.

C. — Quarry face at the top part of Middle Eocene (Mokattam proper). It is located about 1.3 kilometres ENE of the citadel and looking WSW. The reef in the foreground is a fault-breccia left standing in quarry operations. It strikes parallel to the fault visible in the right portion of the photograph.

D. — Shows the same fault-breccia bordered by a fault plane.



A

B

C

D

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